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INNOVATION RESEARCH PROGRAM (SBIR)(U) DEPARTMENT OF
DEFENSE WASHINGTON DC SMALL BUSINESS INNOVATION..
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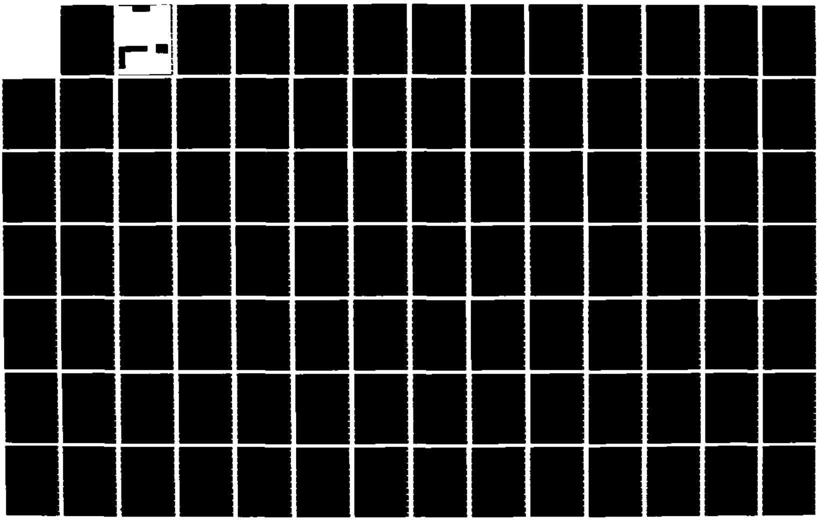

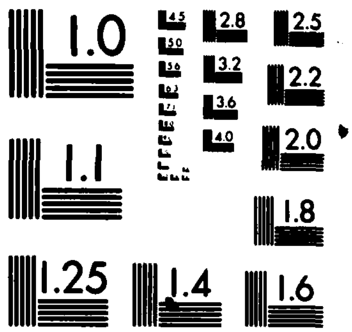
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PROGRAM SOLICITATION
Number 87.1
Small Business
Innovation Research
Program

Issue Date: 1 October 1986

U.S. Department of Defense

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Washington, DC 20301

Closing Date: 9 January 1987

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DOD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Army, Navy, Air Force, Defense Advanced Research Projects Agency (DARPA), Defense Nuclear Agency (DNA), and Strategic Defense Initiative Organization (SDIO), hereafter referred to as DOD Components, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms with strong research and development capabilities in science or engineering in any of the topic areas described in Appendix D are encouraged to participate. Subject to the availability of funds, DOD Components will support high quality research or research and development proposals on innovative concepts related to the listed defense-related scientific or engineering problems.

Objectives of the DOD-SBIR Program include stimulating technological innovation in the private sector, strengthening the role of small business in meeting DOD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DOD-supported research or research and development results.

The Federal SBIR Program is mandated by Public Law (PL 97-219). The basic design of the DOD SBIR program is in accordance with the Small Business Administration (SBA) National Directive, #65-01.2. The DOD program presented in this solicitation brochure strives to encourage scientific and technical innovation in areas specifically identified by DOD components. The guidelines presented in this Solicitation incorporate and exploit the flexibility of the SBA National Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DOD, rather than proposals focused on and built around a specific dollar level. In accordance with the National Directive, the DOD-SBIR Program is a three phase program as described in Section 1.2. Results from prior years are shown in Section 1.6.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, Public Law 97-219. Under Phase I, DOD Components anticipate making 900 awards during fiscal year 1987 to small businesses typically of one-half to one man-year effort over a period generally not to exceed six months, subject to negotiation. The legislative history of PL 97-219 clearly envisioned that the Phase I awards would be in the neighborhood of $50,000 each, adjusted for inflation. Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR program. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DOD support in Phase II. The measures of Phase I success include evaluations of the extent of which Phase II results have the potential to yield a product or process of continuing importance to DOD.

Subsequent Phase II awards will be made only to firms on the basis of results from the Phase I effort, and the scientific and technical merit of the Phase II proposal. In FY-88 DOD anticipates making 300 Phase II awards from the Phase I awards in FY-87. Phase II awards will typically cover 2 to 5 man-years of effort over a period generally not to exceed 24 months, subject to negotiation. The legislative history of PL 97-219 clearly envisioned that the Phase II awards would be in the neighborhood of $500,000. The number of Phase II awards will depend upon Phase I results and availability of funds. Phase II is the principal research or research and development effort and is expected to produce a well defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, non-Federal capital is expected to be used by the small business to pursue commercial applica-

This document describes [illegible]

tions of the research or development. Also, under Phase III, Federal agencies may award non SBIR-funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed, in part, to provide incentives for the conversion of Federally-sponsored research and development innovation in the private sector. The Federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential. Proposers are asked to consider whether the research and development they are proposing to DOD Components also has commercial possibilities, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the Government funded research and development phases.

Both Phase I and Phase II contracts may include a profit or fee.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will *not* be considered under this soliciation; however, offerors who were *not* awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in Appendix D hereto.

For Phase II, no separate solicitation will be issued as only those sources that were awarded Phase I contracts will be considered (Section 6.3 and 7.2).

DOD is not obligated to make any awards under either Phase I, II or III. DOD is not responsible for any monies expended by the proposer before award of any contract.

1.3 Follow-on Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is the conversion of DOD supported research or research and development into technological innovation by private firms. Therefore, on an optional basis, the DOD program includes an incentive for proposers to obtain a contingent commitment for private follow-on funding prior to Phase II to continue the innovation process where it is felt that the research or research and development also have commercial potential.

Proposers who feel that their research or research and development have the potential to meet market needs, in addition to meeting the DOD objectives, are encouraged to obtain non-Federal follow-on funding for Phase III to pursue commercial development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent on the DOD supported research or development meeting some specific technical objectives in Phase II which if met, would justify non-Federal funding to pursue further development for commercial purposes in Phase III. Note that when several Phase II proposals are evaluated as being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process.

The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or II, subject to the patent policies as stated in this solicitation Section 7.7).

1.4 Eligibility and Limitations

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the cover sheet (Appendix A) of his proposal. In addition, a minimum of two-thirds of each SBIR project must be carried out by the proposing firm. For Phase II a minimum of one-half of the effort must be performed by the proposing firm. For both Phase I and II the primary employment of the principal investigator must be with the small business firm at the time of award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Deviations from these requirements must be approved in writing by the contracting officer.

For both Phase I and Phase II the research or research and development work must be performed by the small business concern in the United States. "United States" means the several states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided the entity created qualifies as a small business in accordance with the Small Business Act, 15 USC 631, and the definition included in this solicitation.

1.5 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of the Ethics in Government Act of 1978 (P.L. 95-521, as amended by P.L. 96-19 and P.L. 96-28). Such proposers should contact the cognizant Ethics Counsellor of the DOD component for further guidance.

1.6 Prior Years Results

FY-83	Number of Topics	Proposals Received	Phase I Awards	Phase II Awards
Army	182	1246	96	48
Navy	131	944	67	45
Air Force	75	496	100	49
DARPA	8	128	12	8
DNA	10	88	8	2
	406	2902	283	152

FY-84	Number of Topics	Proposals Received	Phase I Awards	Phase II Awards
Army	111	758	81	21
Navy	147	861	99	49
Air Force	283	1208	163	71
DARPA	17	107	15	7
DNA	8	80	12	0
	566	3014	370	*148

FY-85	Number of Topics	Proposals Received	Phase I Awards	Phase II Awards
Army	111	808	125	*33
Navy	138	851	110	
Air Force	218	1272	236	
DARPA	17	130	14	
DNA	7	95	18	
SDIO	18	419	37	
	509	3575	540	*33

FY-86	Number of Topics	Proposals Received	No. Selected for Phase I Negotiations
Army	225	1638	265
Navy	190	1261	201
Air Force	304	1756	338
DARPA	22	177	35
DNA	7	171	49
SDIO	12	550	153
	760	5553	1041

*Awards made as of August 1986

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development — Any activity which is (A) a systematic, intensive study directed toward greater knowledge or understanding of the subject studied; (B) a systematic study directed specifically toward applying new knowledge to meet a recognized need; or (C) a systematic application of knowledge toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements. In DOD's R&D Program the definitions A, B, and C above correspond respectively as follows: (A) Basic Research, (B) Exploratory Development, and (C) Advanced Development or Engineering Development.

2.2 Small Business—A small business concern is one that, at the time of award of a Phase I or Phase II contract:

- **a.** Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;
- **b.** Is at least 51 percent owned, or in the case of a publicly owned business, at least 51 percent of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;
- **c.** Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR Part 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 U.S.C. 661, *et seq.*, are affiliates of one another when either directly or indirectly (A) one concern controls or has the power to control the other; or (B) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR 121.3-2(a). The term "number of employees" is defined in 13 CFR 121.3-2(t). Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Minority and Disadvantaged Small Business A small business that is:

- a. At least 51% owned by one or more minority and disadvantaged individuals; or, in the case of any publicly owned business, at least 51% of the voting stock of which is owned by one or more minority and disadvantaged individuals; and
- b. Whose management and daily business operations are controlled by one or more of such individuals.

While these individuals and small concerns will be required to compete for SBIR on the same basis as all other small business, attention will be given to a special outreach effort to ensure that minority and disadvantaged firms will have notice of this solicitation.

A minority and disadvantaged individual is defined as a member of any of the following groups: Black Americans; Hispanic Americans; Native Americans; Asian-Pacific Americans; or Asian-Indian Americans.

2.4 Women-Owned Small Business — A women-owned small business is that which is at least 51 percent owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management.

2.5 Subcontract — A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Goverment contract awardee calling for supplies or services required solely for the performance of the original contract.

3.0 TECHNICAL TOPICS

Topics for each DOD Component are listed and numbered separately. Topics and topic descriptions are provided in Appendix D.

4.0 PHASE I PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

4.1 Proposal Requirements

A proposal to any DOD component under the SBIR program is to provide sufficient information to persuade the DOD Component that the proposed work represents a sound approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

Those responding to this solicitation should contact the Defense Technical Information Center (DTIC) for scientific and tehnical information assistance as described in Section 8.0. Background information available from DTIC on each of the topics listed in Appendix D can facilitate better informed decisions to bid or not to bid and may enhance the technical quality of a proposal by demonstrating more thorough knowledge of related work already completed or underway by DOD Components and others.

A proposal should be self-contained and written with care and thoroughness. Each proposal should be reviewed carefully by the offeror to ensure inclusion of all data essential for evaluation.

The scientific or technical merit of the proposed research or research and development is the primary concern for all research and development supported by the DOD. *A proposal must respond to only one of the topics listed in Appendix D.* An organization may submit separate proposals on different topics or different proposals on the same topic but each proposal must be limited to one topic. Where similar research and development is discussed in more than one topic description, the proposer should choose that topic the description of which appears most relevant to the proposer's technical concept.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the DOD program objectives, but can also serve as the base for technological innovation, new commercial products, process, or services which benefit the public.

If a proposal substantially the same as the one submitted in response to this solicitation has been previously funded or is either funded by, pending with, or about to be submitted to another Federal agency or another DOD Component, or to the same DOD Component as a separate action, the proposer must so indicate and provide the information required by Section 4.4 1.

4.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary, commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 7.8.

4.3 General Content

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of *no more than 25 pages*, (no type smaller than elite on standard 8 1/2" × 11" paper with one (1) inch margins, 6 lines per inch) including proposal cover sheet (Appendix A), Project Summary (Appendix B) and Cost Proposal (Appendix C) and any enclosures and attachments. Promotional and non-project-related discussion is discouraged. *Cover all items listed below in Section 4.4 in the order given.* The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, no additional attachments, appendices or references beyond the 25-page limitation will be considered in proposal evaluation, and proposals in excess of the 25-page limitation will not be considered for review or award.

The proposal must address the research or research and development proposed on the specific topic chosen. It is not necessary to provide a lengthy discourse on the commercial applications in the Phase I proposal except to discuss them briefly as described in Section 4.4, items b and h.

4.4 Phase I Proposal Format

All pages shall be consecutively numbered.

a. Cover Sheet. Photocopy and complete the form in Appendix A as page 1 of each copy of each proposal.

b. Project Summary. Photocopy and complete the form identified as Appendix B as page 2 of your proposal. The technical abstract should include a brief description of the project objectives, and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. *The Project Summary of successful proposals will be submitted for publication with unlimited distribution and, therefore, should NOT contain proprietary or classified information.*

c. Identification and Significance of the Problem or Opportunity. Define the specific technical problem or opportunity addressed and its importance. (Begin on page 3 of your proposal.)

d. Phase I Technical Objectives. Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. Phase I Work Plan. This section must provide an explicit, detailed description of the Phase I approach. The plan should indicate not only what is planned but how and where the work will be carried out. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be substantial portion of the total proposal.

f. Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, by the proposing firm, consultants, or others, how it interfaces with the proposed project, and any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic. Use of DTIC is encouraged.

g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.
(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Potential Post Applications. Briefly describe:

(1) Whether and by what means the proposed project appears to have potential commercial application.
(2) Whether and by what means the proposed project appears to have potential use by the Federal Government.

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this Section.

k. Consultants. Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail, and identified in Appendix C. A minimum of two-thirds of each SBIR project must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current or Pending Support. If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been or is funded by, or is pending with another Federal Agency or DOD Component or to the same DOD Component, the proposer must provide the following information:

(1) The name and address of the Federal Agency(s) or DOD Component to which a proposal was submitted, or will be submitted, or from which an award is expected or has been received.
(2) Date of proposal submission or date of award.
(3) Title of proposal.
(4) Name and title of principal investigator for each proposal submitted or award received.
(5) Title, number, and date of solicitation(s) under which the proposal was submitted or will be submitted or under which award is expected or has been received.
(6) If award was received, state contract number.
(7) Specify the applicable topics for each pending SBIR proposal submitted or award received.

Note: If Section 4.4 l does not apply, please state in the proposal "No prior, current or pending support for a similar proposal."

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Under the direct labor category, list all key personnel by name as well as by number of hours dedicated to the project. **(See also Section 7.9).**

4.5 Bindings

Do not use special bindings or covers. Staple the pages in the upper left hand corner of each proposal.

5.0 SUBMISSION OF PROPOSALS

Five (5) copies of each proposal or modification will be submitted, in a single package, as described below.

5.1 Address

Proposals (5 copies) and modifications thereof must be addressed to that DOD Component address which is identified for each topic in each Component's section of Appendix D to this solicitation.

One copy must be an original signed by the principal investigator *and* an official empowered to commit the proposer. Other copies may be photocopied.

The name and address of the offeror, the solicitation number and the topic number for the proposal must be clearly marked on the face of the envelope or wrapper.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secure packaging is mandatory. The DOD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal should be sent in the same package. Do not send separate "information" copies or several packages containing parts of the single proposal.

5.2 Deadline for Proposals

Deadline for receipt (5 copies) at the DOD Component is 2:00 p.m. local time, January 9, 1987. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (a) it was sent by registered or certified mail not later than January 2, 1987 or (b) it was sent by mail and it is determined by the Government that the late receipt was due solely to mishandling by the Government after receipt at the Government installation.

The only acceptable evidence to establish (a) the date of mailing of a late received proposal sent either by registered mail or certified mail is the U.S. Postal Service postmark on the wrapper or on the original receipt from the U.S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term "postmark" means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U.S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye "postmark" on both the receipt and the envelope or wrapper; (b) the time of receipt at the Government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal prior to award. (NOTE: the term "telegram" includes mailgrams.)

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages. Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the Government will be considered at any time it is received and may be accepted.

6.0 METHOD OF SELECTION AND EVALUATION CRITERIA

6.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror says otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the chosen topic. Those found to be relevant will then be evaluated using the criteria listed in Section 6.2. Final decisions will be made by the DOD Component based upon these criteria and consideration of other factors, including possible duplication of other work, and program balance. A DOD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DOD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a government contracting officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will

be conducted between the offeror and the government contracting officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to a technical review process similar to Phase I. Final decisions will be made by DOD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research, development, program balance, budget limitations and the potential of a successful Phase II effort leading to a product of continuing interest to DOD.

6.2 Evaluation Criteria—Phase I

The DOD components plan to select for award those proposals offering the best value to the Government with approximately equal consideration given to each of the following criteria, except for number one which will receive twice the weight of any other item:

a. The scientific/technical quality of the Phase I research or research and development proposal and its relevance to the topic description, with special emphasis on its innovation and originality.
b. Qualifications of the principal investigator, other key staff, and consultants, if any, and the adequacy of available or obtainable instrumentation and facilities.
c. Anticipated benefits of the research or research and development to the total DOD research and development effort.
d. Adequacy of the Phase I proposed effort to show progress toward demonstrating the feasibility of the concept.

Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referred-to experiments. Relevant supporting data such as journal articles, literature, including government publications, etc., should be identified in the proposal.

6.3 Evaluation Criteria—Phase II

A Phase II proposal can be submitted only by a Phase I awardee. Phase II is *not* initiated by a solicitation. Detailed instructions regarding Phase II proposal submission will be sent by DOD Components to all Phase I award winners. Listed below are some of the principles upon which those instructions can be expected to be based.

A Phase II proposal can be submitted at any time when progress attained under Phase I is deemed sufficient to justify the effort to be proposed for Phase II. (See Section 7.2.) It must contain enough information on progress accomplished under Phase I by the time of Phase II proposal submission to enable an evaluation of the project's promise if continued into Phase II. The Phase II proposal will be reviewed for overall merit based upon the criteria below. Each item will receive approximately equal weight, except for item one, which will receive twice the value of any other item:

a. The scientific/technical quality of the proposal, with special emphasis on its innovation and originality.
b. The qualifications of the principal investigator and other key personnel to carry out the proposed work.
c. Anticipated benefits of the research or development to the total DOD research and development effort.
d. Degree to which the Phase I objectives were met at the time of Phase II proposal submission.
e. The adequacy of the Phase II objectives to meet the problem or opportunity.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the Government. Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offerer.

In the case of proposals of approximately equal merit, the provision of a follow-on Phase III funding commitment for continued development from non-Federal funding sources will be a special consideration. The follow-on funding commitment must provide that a specific amount of Phase III funds will be made available to or by the small business and indicate the dates the funds will be made available. It must also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms cannot be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment shall be submitted with the Phase II proposal.

Phase II proposal evaluations may include on-site evaluations by Government personnel of the Phase I effort.

7.0 CONTRACTUAL CONSIDERATIONS

7.1 Awards (Phase I)

The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim period Phase I modifications, and Phase II contracts.

No Phase I contracts will be awarded until all qualified proposals (received in accordance with section 5.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than July 31, 1987. The names of those firms receiving awards will be announced.

7.2 Awards (Phase II)

The number of the Phase I awardees that will receive Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. Phase II is to further develop ideas explored under Phase I. Specific instructions for the preparation of Phase II proposals will be included in the Phase I contract. Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II work and the costs associated therewith. These Phase II proposers may be issued a modification to the Phase I contract, at the discretion of the Government, coverning an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated. This modification would normally become effective at the completion of Phase I or as soon thereafter as possible. Funding, scope of work, and length of performance for this interim period will be subject to negotiations. Issuance of a contract modification for the interim period does not commit the Government to award a Phase II contract.

Offerors for Phase II work who do not elect to submit a proposal 30 days prior to the expiration date of the Phase I contract, have the option to submit a proposal after the completion of the Phase I contract. The final date for receipt of a Phase II proposal will be not later than 60 calendar days after the completion of the Phase I contract.

The period of performance under Phase II will depend upon the scope of the effort, but generally will not exceed 24 months. Phase II award decisions will be based upon evaluation of progress attained under Phase I and of the Phase II proposal. Phase II awards will typically cover 2 to 5 man-years effort, depending upon the scope of research or development.

7.3 Reports

Six copies of a final report on the Phase I project must be submitted to the DOD Component in accordance with the negotiated delivery schedule. This will normally be within thirty days after completion of the Phase I effort. The final report shall include a single-page project summary as the first page identifying the purpose of the work, a brief description of the work carried out, the findings or results, and potential applications of the effort. *The summary may be published by DOD and therefore must not contain proprietary or classified information.* The balance of the report should indicate in detail the project objectives, work carried out, results obtained, and estimates of technical feasibility.

To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes only to accommodate results obtained after Phase II proposal submission, and modifications required to integrate the final report into a self-contained, comprehensive and logically structured document.

7.4 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon negotiations between the DOD and the successful Phase I offeror. SBIR performers may be paid under an applicable, authorized progress payment procedure or in accordance with a negotiated price and payment schedule. When progress payments are authorized the participating small business will be required to submit interim progress reports to the contracting officer. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Advanced payments are optional and may be made under appropriate public law when it is determined to be in the best interest of the Government.

7.5 Technical Data

Rights in technical data, including software, developed under the terms of any contract results from proposals submitted in response to this solicitation shall remain with the contractor, except that the Government shall have the limited right to use such data for Government purposes and shall not release such data outside the Government without permission of the contractor for a period of two years from completion of the project from which the data was generated unless the data has already been released to the general public. However, effective at the conclusion of the two-year period, the Government shall retain a royalty-free license for Government use of any technical data delivered under an SBIR funding agreement whether patented or not.

7.6 Copyrights

With prior written permission of the contracting officer, and to the extent permitted by statute the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DOD support. DOD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

7.7 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with Government support. The Government receives a royalty-free license for its use, reserves the right to require the patentholder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the Government will not make public any information disclosing a Government-supported invention for a two-year period to allow the awardee a reasonable time to pursue a patent.

7.8 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data, which the proposer does not want disclosed to the public or used by the Government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer. The government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "confidential proprietary information" and provided that the following legend appears on the title page of the proposal:

> "For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the government shall have the right to duplicate, use, or disclose the data to the extent provided in the contract. This restriction does not limit the government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s) ________ of this proposal."

Any other legend may be unacceptable to the government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

> "Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

The government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information he will be requested to expeditiously submit to the DOD Component a detailed listing of all information in his proposal which he believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DOD Component pursuant to the Act is properly determined.

Those proposers that have classified facility clearance may submit classified material with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industral Security Manual for Safeguarding Classified Information (DOD 5220.22M) procedures for marking and handling classified material.

7.9 Cost Proposal

A firm fixed price or cost plus fixed fee Phase I proposal must be submitted in detail in the format shown in Appendix C. Note: The firm fixed price type is the preferred method for Phase I proposals. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information for each and every item. What matters is that enough information be provided to allow the DOD Component to understand how the proposer plans to use the requested funds if the contract is awarded. Phase I contract may include a profit or fee.

a. Special Tooling and Test Equipment, and Material. Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed.

The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the *Government* and should be related directly to the specific topic. They may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the Government or acquired with Government funds, will be vested with the DOD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DOD Component.

b. **Travel.** Cost for travel funds must be justified and related to the needs of the project.

c. **Cost-Sharing.** Cost-sharing is permitted for proposals under this solicitation; however, cost-sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

7.10 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the federal acquisition regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. **Standards of Work.** Work performed under the contract must conform to high professional standards.

b. **Inspection.** Work performed under the contract is subject to Government inspection and evaluation at all reasonable times.

c. **Examination of Records.** The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. **Default.** The Government may terminate the contract if the contractor fails to perform the work contracted.

e. **Termination for Convenience.** The contract may be terminated at any time by the Government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. **Disputes.** Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. **Contract Work Hours.** The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).

h. **Equal Opportunity.** The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. **Affirmative Action for Veterans.** The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. **Affirmative Action for Handicapped.** The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. **Officials Not to Benefit.** No member of or delegate to Congress shall benefit from the contract.

l. **Covenant Against Contingent Fees.** No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bonafide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. **Gratuities.** The contract may be terminated by the Government if any gratuities have been offered to any representative of the Government to secure the contract.

n. **Patent Infringement.** The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. **Military Security Requirements.** The Contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

8.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

8.1 DOD Technical Information Services Available

Recognizing that small businesses may not have strong technical information service support, the Defense Technial Information Center (DTIC) is prepared to give special attention to the needs of DOD SBIR Program participants.

Many of the 6000 small business requestors who responded to FY-83 through FY-86 DOD SBIR Program solicitations believe that the scientific and technical information which DTIC provided enabled them to make better informed bid/no bid decisions and prepare technically stronger proposals. People responding to this

solicitation are encouraged to contact DTIC for bibliographies of technical reports that have resulted from prior DOD-funded R&D, for copies of the technical reports which are cited in these bibliographies, and for information about DOD-sponsored work currently in progress in their proposal topic areas.

DTIC is the central source of scientific and technical information resulting from and describing R&D projects that are funded by DOD. DTIC searches this information for registered requesters. Reasonable quantities of paper or microfiche copies of requested documents are available for SBIR Program proposal preparation.

DTIC will also provide referrals to DOD-sponsored Information Analysis Centers (IACs) where specialists in mission areas assigned to these IACs perform informational and consultative services.

DTIC assistance will include references to other sources of scientific and technical information needed to prepare SBIR Program proposals to DOD. Call or visit DTIC at the following location which is most convenient to you.

All written communications with DTIC must be made to the Cameron Station, Alexandria, VA, address.

Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 368-5211 (Toll free)
(202) 274-6902 (Commercial for Virginia, Alaska and Hawaii)

DTIC Boston On-Line Service Facility
AFGL Research Library/SULL
Building 1103, Hanscom AFB
Bedford, MA 01731
(617) 377-2413

DTIC Los Angeles On-Line Service Facility
Defense Contract Administration Services Region
222 N. Sepulveda Blvd.
El Segundo, CA 90245-4320
(213) 335-4170

Use reference A at the back of this solicitation to request background bibliographies and descriptions of work in progress related to those topic areas which you plan to pursue under this solicitation. DTIC will return the material you request, annotated with a temporary User Code. This User Code is to be used by you when requesting additional information or when ordering documents cited in a bibliography until the solicitation closing date.

Because solicitation response time is limited, submit your requests for DTIC's information services as soon as possible.

8.2 Other Technical Assistance Program

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

University of Southern California
Western Research Applications Center (WESRAC)
3716 S. Hope Street #200
Los Angeles, California 90007
(213) 743-6132

NERAC, Inc.
Mansfield Professional Park
Storrs, Connecticut 06268
(203) 429-3000

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600

Aerospace Research Applications Center
P.O. Box 647
Indianapolis, Indiana 46223
(317) 264-4644

Kerr Industrial Applications Center
Southeastern Oklahoma State University
Durant, Oklahoma 74701
(405) 924-6822

North Carolina Science and Technology Research Center
Post Office Box 12235
Research Triangle Park, North Carolina 27709
(919) 549-0671

NASA Industrial Applications Center
701 LIS Building
University of Pittsburgh
Pittsburgh, Pennsylvania 15260
(412) 624-5211

NASA/UK Technology
University of Kentucky
109 Kinkead Hall
Lexington, Kentucky 40506
(606) 257-6322

NASA/Florida State Technology Applications Center
State University System of Florida
500 Weil Hall
Gainesville, Florida 32611
(904) 392-6626

9.0 CONTACT WITH DOD

9.1 Oral Communications

Oral communications with DOD Components regarding this solicitation during the Phase I proposal preparation period are prohibited for reasons of competitive fairness, with the exceptions as stated in Section 8.0, 9.7 and Appendix D.

9.2 Questions Pertaining to This Solicitation

Questions pertaining to this solicitation should be addressed in writing to the address listed at the beginning of each DOD Component listing of topics (See Appendix D). No telephone requests will be accepted except as stated in Section 9.1.

9.3 Requests for Additional Copies of This Solicitation

Additional copies of this solicitation can be ordered from the Defense Technical Information Center. Attn: DTIC/SBIR, Building 5, Cameron Station, Alexandria, Virginia 22304-6145; (telephone (800) 368-5211 (toll free)/(202) 274-6902 (commercial for Virginia, Alaska and Hawaii).

9.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

9.5 Debriefing of Unsuccessful Offerors

After final award decisions have been announced a debriefing may be provided to unsuccessful offerors, on their proposals only, upon written request.

9.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number, specific topic number and be addressed to the DOD Component whose address is associated with each topic number.

9.7 Counseling Assistance Available

Small business firms interested in participating in the SBIR Progam may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Administration Services (DCAS) activities throughout continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See reference C at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to DCAS Activities.)

9.8 Notifications of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self addressed and stamped envelope and a copy of the notification form (reference B) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the goverment does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 5.2.

10.0 ADDITIONAL INFORMATION

10.1

This Program Solicitation is intended for informational purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

10.2

Before award of an SBIR contract, the Government may request the proposer to submit certain organizational, management, personnel and financial information to confirm responsibility of the proposer.

10.3

The Government is not responsible for any monies expended by the proposer before award of any contract.

10.4

This Program Solicitation is not an offer by the Government and does not obligate the Government to make any specific number of awards. Also, awards under this program are contingent upon the availability of funds.

10.5

The SBIR program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals will not be accepted under the SBIR program in either Phase I or Phase II.

10.6

If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

10.7

If classified work is proposed or classified information is involved, the Offeror to this solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DOD 5220.22M).

Appendix A
Solicitation No. 87.1
Proposal Cover Sheet

DEFENSE SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

Topic Number: ______ ☐ Army ☐ Navy ☐ Air Force ☐ DARPA ☐ DNA ☐ SDIO

Proposal Title ____

____

Submitted By: Firm ____

Address ____

City ______________________ State ______ Zip Code ______

Submitted To: (Activity identified with the topic) ____

____

Address ____

City ______________________ State ______ Zip Code ______

Small Business Certification:

The above firm certifies it is a small business firm and meets the definition stated in the Small Business Act 15 U.S.C. 631 and in the Definition Section of the Program Solicitation.

"The above firm certifies that it qualifies as a minority or disadvantaged small business as defined in the Definition Section of the Program Announcement." Yes _____ No _____.

The above firm certifies that it qualifies as a woman-owned small business firm : Yes _____ No _____.

This proposal has been submitted to other US Government agency/agencies:

Yes ________ ; Name(s) ____
No ________

Disclosure permission statement as follows:

All data on Appendix A is releasable information. All data on Appendix B, for an awarded contract, is also releasable.

"Will you permit the Government to disclose the information on Appendix B, if your proposal does not result in an award, to any party that may be interested in contacting you for further information or possible investment? Yes _____ No _____."

Number of employees including all affiliates (average for preceding 12 months): __________

Proposed Cost (Phase I): __________ Proposed Duration: _____ months (not to exceed six months).

Project Manager/Principal Investigator	Corporate Official (Business)
Name ______________________	Name ______________________
Title ______________________	Title ______________________
Signature ______________________	Signature ______________________
Date ______________________	Date ______________________
Telephone ______________________	Telephone ______________________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s) ________ of this proposal. Failure to fill in all appropriate spaces may cause your proposal to be disqualified.

Nothing on this page is classified or proprietary information/data

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH PROGRAM
PHASE 1 – FY 1987
PROJECT SUMMARY

Topic No. ________ Military Department/Agency ________ .

Name and Address of Proposing Small Business Firm

Name and Title of Principal Investigator

Proposal Title

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development

List a maximum of 8 Key Words that describe the Project.

Nothing on this page is classified or proprietary information/data

APPENDIX C
COST PROPOSAL
DEFENSE SMALL BUSINESS INNOVATION RESEARCH PROGRAM (SBIR)

Background:

The following items, as appropriate, should be included in proposals responsive to the DOD Solicitation Brochure

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DOD Solicitation Brochure
6. Total Dollar amount of the proposal (dollars)
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost) (dollars)
   d. Total direct material (dollars)
8. Material overhead (rate ____%) × total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type.
   b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost.
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at Government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transporation (detailed breakdown and dollars)
    b. Per Diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Consultants
    a. Identify each, with purpose, and dollar rates
    b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalites (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars)
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any excutive agency of the United States Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone/extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-free or firm-fixed price.

APPENDIX D

Technical Topics

Topics for each DoD components are listed and numbered seperately:

ARMY 1987

SBIR SOLICITATION

INTRODUCTION

It is important that the SBIR proposal be prepared with care in order to facilitate its consideration. Specifically, a valid proposal shall:

(1) Be innovative, unique, or meritorious.

(2) Be independently originated and developed by the offeror.

(3) Include sufficient detail to permit a determination that the Government's support could be worthwhile, and that the proposed work could benefit the Army's Research and Development or other mission responsibilities.

(4) Not be an advance proposal for a specific documented Army requirement that can be acquired by other competitive methods.

The contracting office will insert a special clause in the Phase I contract similar to an option clause identifying the specific time frame for submission of Phase II proposals. For cost type contracts, it is imperative that Small Business' have an accounting system adequate for determining costs applicable to the contract. The contracting office will insert an option clause in the Phase I contract to cover an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated. (See Section 7.2 awards). The contracting office requires monthly technical and fiscal reports for both Phase I and Phase II contracts.

Final reports shall be required for both Phase I and Phase II Army SBIR projects. These reports are to be submitted in connection with the final update of the DD Form 1498 - Research and Technology Work Unit Information Summary which is managed by the Defense Technical Information Center (DTIC). The contracting office shall incorporate a requirement that the DD Form 1498 be furnished to DTIC and to the Government Technical Program Manager who shall assure that appropriate interim updates are provided to DTIC. This information system will serve as the central data base for the Army SBIR Program.

For general questions on the Army Solicitation topics, please call Army SBIR Program Manager J. Patrick Forry - Telephone (202)394-3014.

Topics A87-001 - A87-026	Commander U.S. Army Armament, Munitions and Chemical Command Armament Research and Development and Engineering Center ATTN: SMCAR-RAM SBIR Program Dover, NJ 07801-5001
Topics A87-027 - A87-030	Commander U.S. Army Armament, Munitions and Chemical Command Chemical Research, Development and Engineering Center ATTN: AMSMC-PC-B(A) Mr. Henry Procurement Directorate Edgewood Site/Bldg. E4455 Aberdeen Proving Ground, MD 21010
Topics A87-031 - A87-040	Commander U.S. Army Aviation System Command ATTN: AMSAV-PSRS SBIR Program Building 102 4300 Goodfellow Blvd. St. Louis, MO 63120-1798
Topics A87-041 - A87-067	Director U.S. Army Harry Diamond Laboratories ATTN: SLCHD-PO-D (Dr. Stan Kulpa) SBIR Program 2800 Powder Mill Road Adelphi, MD 20783-1197
Topic A87-068	Commander U.S. Army Vulnerability Assessment Laboratory ATTN: SLCVA-TAC (Mrs. J. Arthur) Building 1624 Room 101 SBIR Program White Sands Missile Range, NM 88002-5513

Topics A87-069 - A87-073	Commander U.S. Army Atmospheric Sciences Laboratory ATTN: SLCAS-DP-P Building 1622, Room 106 SBIR Program White Sands Missile Range, NM 88002-5501
Topics A87-074 - A87-097	Director U.S. Army Ballistic Research Laboratory ATTN: SLCBR-D-DA (Puckett) SBIR Program Aberdeen Proving Ground, MD 21005-5066
Topics A87-098 - A87-101	Director U.S. Army Human Engineering Laboratory ATTN: SLCHE-SA (S. Kerns) SBIR Program Aberdeen Proving Ground, MD 21005-5001
Topics A87-102 - A87-114	Director U.S. Army Materials Technology Laboratory ATTN: SLCMT-TPP, Program Planning Division Building 131, Room 143 405 Arsenal Street SBIR Program Watertown, MA 02172-0001
Topic A87-115	Director U.S. Army Research Office ATTN: SLCRO-EG P.O. Box 12211 SBIR Program Research Triangle Park, NC 27709-2211

Hand Delivery Address

U.S. Army Research Office
ATTN: SLCRO-EG
4300 S. Miami Blvd.
Research Triangle Park, NC 27709-2211

Topics A87-116 - A87-134	Director U.S. Army Electronic Technology and Devices Laboratory ATTN: SLCET-DT (R. Stern) SBIR Program Fort Monmouth, NJ 07703-5302
Topics A87-135 - A87-148	Commander U.S. Army Belvoir RD&E Center Procurement and Production Directorate ATTN: AMSTR-PVD Building 314, Receptionist SBIR Program Ft. Belvoir, VA 22060-5606
Topics A87-149 - A87-155	Commander U.S. Army Missile Command ATTN: AMSMI-PC-BBA Building 4488 SBIR Program Redstone Arsenal, AL 35898-5280
Topics A87-156 - A87-172	Commander U.S. Army Tank-Automotive Command ATTN: AMSTA-IRSA (Building 200A) SBIR Program Warren, MI 48397-5000

Topics A87-173 - A87-181	Director U.S. Army Natick Research and Development and Engineering Center ATTN: AMSTR-PW SBIR Program Natick, MA 01760-5011
Topics A87-182 - A87-186	Commander U.S. Army Aberdeen Proving Ground Installation Support Activity ATTN: STEAP-PR (SBIR Program) Aberdeen Proving Ground, MD 21005-5001
Topics A87-187 - A87-199	Commander U.S. Army Dugway Proving Ground ATTN: STEDP-PR (SBIR Program) Dugway, UT 84022-5000
Topics A87-200 - A87-213	Commander U.S. Army White Sands Missile Range ATTN: STEWS-PR (SBIR Program) White Sands Missile Range, NM 88002-5031
Topics A87-214 - A87-218	Commander U.S. Army Jefferson Proving Ground ATTN: STEJP-LD-P (SBIR Program) Madison, IN 47250-5100
Topics A87-219 - A87-220	Commander U.S. Army Cold Regions Test Center ATTN: STECR-TA (SBIR Program) APO Seattle 98733-7850
Topics A87-221 - A87-224	Commander U.S. Army Yuma Proving Ground ATTN: STEYP-PC (SBIR Program) Yuma, AZ 85365-9102

Topics A87-225 - A87-234	**Commander U.S. Army Test & Evaluation Command ATTN: AMSTE-PR (SBIR Program Aberdeen Proving Ground, MD 21005-5055**
Topic A87-235	**Commander U.S. Army Aviation Development Test Activity ATTN: STEBG-MP-P (SBIR Program) Fort Rucker, AL 36362-5276**
Topics A87-236 - A87-238	**Commander U.S. Army Electronic Proving Ground ATTN: STEEP-TM-AC (SBIR Program) Fort Huachuca, AZ 85613-7110**
Topics A87-239 - A87-244	**Commander U.S. Army Engineering Topographic Laboratories ATTN: ETL-PR-P Building 2592 SBIR Program Ft. Belvoir, VA 22060-5546**
Topics A87-245 - A87-259	**Commander U.S. Army Construction Engineering Research Laboratory ATTN: Chief Procurement and Supply Branch 2902 Newmark Drive Building #1, Room 175-1 SBIR Program Champaign, IL 61820-1305**
Topics A87-260 - A87-261	**Commander U.S. Army Cold Regions Research and Engineering Laboratory ATTN: CRREL-AL 72 Lyme Road SBIR Program Hanover, NH 03755-1290**

Topics A87-262 - A87-270	Commander and Director U.S. Army Waterways Experiment Station ATTN: WESBC (Mary Holman) P.O. Box 631 SBIR Program Vicksburg, MS 39180-0631
Topics A87-271 - A87-285	Commander U.S. Army Medical Research Acquisition Activity ATTN: SGRD-RMC-RC SBIR Program Ft. Detrick Frederick, MD 21701-5014
Topics A87-286 - A87-290	Commander U.S. Army Research Institute For the Behavioral And Social Sciences ATTN: PERI-BR SBIR Program 5001 Eisenhower Avenue Alexandria, VA 22333-0001
Topics A87-291 - A87-304	Commander U.S. Army Communications Electronics Command ATTN: AMSEL-PC-B BID Room SBIR Program Fort Monmouth, NJ 07703-5303
Topics A87-305 - A87-317	Director U.S. Army Night Vision and Electro-Optics Center ATTN: AMSEL-NV-RM-FP (N. Sampsel) SBIR Program Fort Belvoir, VA 22060-5677

Topics A87-318 - A87-322	Director U.S. Army Signals Warfare Center ATTN: AMSEL-SW-OS (Dr. Royal Burkhardt) SBIR Program Vint Hill Farms Station Warrenton, VA 22186-5100

Topics A87-323 - A87-330	Commander U.S. Army Laboratory Command ATTN: AMSLC-TP-PM (Dr. R.E. Bowles) 2800 Powder Mill Road Adelphi, MD 20783-1145

A87-1. TITLE: Adaptive Weapon Pointing and Tracking

DESCRIPTION: Develop a flexible high bandwidth digital weapon pointing and control module capable of implementing state-of-the-art adaptive control and target lead prediction algorithms. The module will be portable and sufficiently rugged for field test bed applications. The module will accept and process current Army weapon sensor information and output control command signals for weapon pointing. System will support high level interactive programming for algorithm development, implementation and validation.

A87-2. TITLE: Application & Comparison of Asphere & Gradient Index Technologies

DESCRIPTION: Investigate applicability of axial gradient and aspheric lens technologies to visible and IR fire control sighting systems. Determine how the two technologies compare for performance enhancement and cost reduction and how they might be coupled in design solutions to fire control sighting problems. Existing optical systems will be evaluated for cost reduction and improved performance as well as unmet military requirements; e.g., riflesight studies. The producibility of the components by fast optical fabrication techniques will be included. The Phase I effort will end in a report describing the results of the study and a preliminary design of a system or subsystem applicable to Army requirements either as a replacement or original item.

A87-3. TITLE: Commandable Safety and Arm Devices for Landmines

DESCRIPTION: There is a need for Safety & Arm Device concepts that can be commanded to repeatedly cycle between a safe or armed condition under electronic command. A safety and arm device is the subsystem of a munition that converts a fuze electronic signal to a explosive output capable of initiating the main warhead and assures by electronic and mechanical means that this output is possible only when a specific munition deployment environment has occurred. It is desirable to remotely command a mine to a safe condition to allow friendly forces to maneuver and then rearm the mine if necessary. The device must be small (less than 2 cubic inches and use minimum transient power (typically a few hundred microfarad capacitor charged to 7 volts, any continuous power should be in the tens of micro ampere range). Reliability should be on the order of .999 for being in a safe condition when commanded. Command signal would be a CMOS device 7 volt logic level. Innovative approaches are needed to reliably convert and direct energy under control within the munition such as optical concepts or use of memory alloys.

A87-4. TITLE: Electromagnetic (EM) Launch Component Technologies

DESCRIPTION: EM Launch technology provides the opportunity for hypervelocity solutions to tactical gun system requirements, but development of innovative approaches in the requisite support technologies

may be necessary. Primary needs are light weight, efficiency and robustness in the areas of: intermediate energy storage (e.g., rotating machines or high-power batteries); launcher subcomponents (e.g., railgun insulators and coilgun structures); and a means to achieve and/or avoid high-current opening switches.

A87-5. TITLE: Intelligent Gunner/Commander Decision Aid

DESCRIPTION: Develop and prototype intelligent tank gunner/commander decision aid for laboratory demonstration and validation. The system should be capable of interfacing with and processing simulated sensor/command, control, communication, and intelligence (C^3I) data and interfacing with tracker hardware for autonomous target acquisition, recognition, and tracking. The system will provide on-line tactical planning with intelligent display and provide flexible environment for artificial intelligence algorithm development and knowledge engineering.

A87-6. TITLE: Robotic Control

DESCRIPTION: Develop and demonstrate an intelligent sensor based robotic control module capable of integrating multi-sensory information, i.e., force/torque, range, vision, tactile and acoustic and perceiving its workspace environment and accomplishing on-line planning to complete a specified part mating/assembly task. The module should provide a flexible programming environment for sensor-based control law development, i.e., compliance control, model reference adaptive control, and task planning. Module should be capable of interfacing with a laboratory Puma 560 robot.

A87-7. TITLE: Robot Vision

DESCRIPTION: Develop prototype 3-D robot vision module and associated algorithms which will permit high speed processing of (arm mounted) camera data and recognition and tracking 3-D objects in the robot work space. The vision module will support high level programming of candidate vision algorithms using standard subroutine libraries and provide interface compatibility with the Puma 560 robot for algorithm validation.

A87-8. TITLE: Design of a Rapid Reload Feeder System

DESCRIPTION: The Combat Vehicle Armament Technology (COMVAT) program is developing a 30mm armament system for the future armored family of vehicles. COMVAT is developing a cased, telescoped ammunition/gun and a twenty round linkless feeder, but there is a need for a full scale feed system. An analysis of ways to efficiently and rapidly reload feed systems is needed. A design of the best system chosen from the analysis will be required. The goal is to design a feed system that will be compatible with future and present resupply vehicles and require little effort from crew and support personnel.

A87-9. TITLE: Maneuverable Projectile Control Technology

DESCRIPTION: Recently developed maneuverable projectiles in the Command Adjusted Trajectory (CAT) program utilize lateral control squibs to divert the projectile from its current trajectory based on command signals generated by a ground tracking system. Due to packaging constraints only a limited number of discrete control events are available to correct for target motion. The purpose of the effort is to improve on the control efficiency of the maneuverable projectile by the development of more efficient guidance and control algorithms. Current system concepts rely on the use of proportional navigation or pursuit navigation laws to effect the control events; however, these methods are not the most efficient ones for this application. Improved guidance schemes are required, that will account for variations in target prediction uncertainty and loss of control authority during the ballistic phase.

A87-10. TITLE: Simultaneous Engagement Armament System

DESCRIPTION: A turreted gun control unit that will allow the attack of threats off axis from the attack helicopter while it is engaged with the attack of armored targets with its missile systems. The unit must be semi-autonomous with its own target sensor/tracker capability but yet linked to the basic System sensors capability and to the pilot.

A87-11. TITLE: Voice Activated Gun Turret Control

DESCRIPTION: A turreted gun control unit that allows the pilot in stressful combat scenarios to receive and provide verbal information to the turret as to target locale, armament status, etc.

A87-12. TITLE: Ammunition Logistics

DESCRIPTION: The ammunition logistics system provides munitions and explosives to the soldier in the field all the way from the manufacturing point. All types of munitions are included, and the system interfaces include packaging, materials handling equipment, transportation, storage, and communications, command and control.

There is a need for a range of items that support this area in the logistics system. Some of these items include:

o Light weight materials for packaging.
o Methods for adhesion of various types of labels to plastic or plastic coated containers.
o Methods for producing enhanced wood products capable of being used in a chemically contaminated environment and being decontaminated.
o Light weight, manpowered, materials handling equipment capable of augmenting existing resupply equipment for light forces.
o Methods for tie-down and securing cargo in a range of large containers.

o Method of improving storage capabilities while meeting safety requirements for munitions.

o Inventory methods and software for igloo storage using electronic storage of data at the igloo.

Given above are a few representative areas for investigation but ideas are being sought across the range of the ammunition logistics system. Proposed enhancements should be specific and well defined to an existing technique or item in the logistics system.

A87-13. TITLE: Software Maintenance Tool

DESCRIPTION: The McCabe Cyclomatic Complexity Metric, as documented in NBS Publication 500-99, is a metric which quantifies the relative complexity of a software module based on the logic constructs used in the algorithm. As this quantity increases, there is a probability that the number of errors in the module will increase. Similarly, the ability of one to understand, and therefore to test and maintain the module decreases. The metric also identifies the minimum number of paths that need to be tested in order to assure the software performs in a consistent and reliable fashion.

The Complexity Analysis Tool (CAT) is an automated tool which analyzes the mission critical computer software (MCCS) source code. This tool currently has the capability of analyzing 3 languages and 2 program design languages (PDL's). As a result, the complexity, data flow diagram, and test paths are generated for each module of the program.

Software changes made during the maintenance phase of the life cycle cost up to 300 times the amount of changes made during initial design. Also, a change in any one of the software modules may have a drastic impact upon the performance of other system components. Because of these facts, a need exists to extend the principles of the McCabe Cyclomatic Complexity Metric and CAT to the system and/or requirements level. A quantitative indication is needed to answer the following questions:

o How maintainable is the system?

o Given various change options, which of these will either improve or have the least effect on the maintainability of the module being changed?

o What other portions of the program might be affected by changing a particular module? How does this effect the program's structure?

o What logical paths of the software must be retested because of the potential effect propagated as a result of one change?

o What modules are the most likely to be problematic from a maintenance point of view?

o What effects do the proposed changes have upon supporting documentation?

The resulting indicator(s) should show the maintenance status of the system as well as indicating high risk areas. This indicator(s) should be

incorporated into the CAT automated tool, and may require use of an expert system.

The overall intent is to develop a comprehensive set of tools based on McCabe's methodologies which will provide measurements through the software development life cycle, and on into post-deployment maintenance.

A87-14. TITLE: Automated Tailoring Assistant for DOD-STD-2167/2168

DESCRIPTION: DOD-STD-2167, Defense System Software Development, and DOD-STD-2168, Defense System Quality Evaluation, are the new DOD standards aimed at software acquisition, development, and support. DOD-STD-2167 establishes requirements for software during its development and acquisition. DOD-STD-2168 establishes the requirements evaluation of software and the establishment of a quality program.

DOD-HDBK-287, Defense System Software Development Handbook, and DOD-HDBK-286, Defense System Software Quality Program Handbook, aid in the application and use of these new standards. By answering a series of questions contained in the handbook in regards to a particular project, a list of applicable DIDs for that project is generated. Another series of questions is used to tailor sections out of each DID so that you are left with a customized list of tailored DIDs and requirements for the software development project.

To result in a more consistent, timely, and efficient utilization of this process, a need exists to have this process transformed into an automated tool. The tool should possess the following capabilities:

- o Be an interactive, user friendly tool, prompting the user for information regarding the software development project.
- o When the tool prompts the user for input, the tool should have the ability to provide the corresponding reference (i.e., DOD-STD-2167, Section XXX states that ....) where the question/information is derived from.
- o Should the questions prove to be subjective in nature, expert system technology should be applied to aid in the decision process, drawing upon past experience or established policies.
- o The tool should have provisions for distinguishing between:
  - o Mission Critical Computer Systems (MCCS) Tactical Items
  - o MCCS Non-Tactical Items
  - o Non-MCCS Items
- o The tool should have an automated report generator, outlining the final requirements and DIDs as tailored.

A87-15. TITLE: Applicability of Ada Compilers for Armament and Munitions

DESCRIPTION: DOD validates Ada compilers to ensure compatibility of the Ada language constructs to those specified in DOD-STD-1815A. However, this validation process makes no attempt to evaluate performance characteristics

of these compilers nor the code they generate for their potential usefulness. For example, I/O, memory usage and timing (i.e., micro-processor overhead) may not meet system design requirements. AMCCOM is finding that certain compiler/processor combinations are not practical for particular armament/munition applications.

AMCCOM needs a way for Ada compilers to be evaluated in terms of their applicability to specific missions critical software development efforts. In addition certain compiler/processor combinations may give rise to particular problems, such as not meeting program operation time constraints, for particular programming constructs. These potential problems need to be determined and documented.

A method for continually assessing Ada compilers and their performance characteristics on target microprocessors must be developed. This method, tool, etc., must have the ability to adapt its assessment capabilities to the requirements of the system for which Ada is to be used, so that it could be applied time and time again.

A87-16. TITLE: Stress Test Assessment Tool (STAT)

DESCRIPTION: The Complexity Analysis Tool (CAT) is an automated tool which analyzes mission critical computer software (MCCS) source code. The tool is based upon the McCabe Cyclomatic Complexity Metric, as documented in NBS Publication 500-99. The metric gives an indication of the relative complexity of a software module based on the logic constructs used in the algorithm. The metric also identifies the minimum number of paths that need to be tested in order to assure the software performs in a consistent and reliable fashion.

Upon analysis of the code, the following are provided for each module of the program:

- o the complexity
- o data flow diagram (program flow mapping), and
- o the test paths which need to be tested.

This tool currently has the capability of analyzing HP-71 BASIC, Equate ATLAS, PDL (Caine, Farber, Gordon), and Ada (MIL-STD-1815A).

Modules with small complexities are tested without too much difficulty. Modules with large complexities often require a greater amount of time and effort to test. Because of various program constraints, these modules are often not thoroughly tested, thus leaving doubt as to their reliability.

A tool is needed to automatically stress test MCCS software to ensure that it does not "crash" when stressed and/or saturated to and beyond established limits. This tool shall utilize the output of CAT, develop a gamut of input for each control taken, and develop the necessary stubs and drivers for each module. With this data, the tool shall then automatically

do stress testing on the software. The testing results should be sent to a report file, noting if the program crashed, accepted bad data, rejected good data, where the error occurred, which data caused the error, etc. The tool may utilize artificial intelligence/expert system technology.

The overall intent is to develop a comprehensive set of tools based on McCabe's methodologies which will provide measurements through the software development life cycle, and on into post-deployment maintenance. The tool described above would further reduce the labor intensive and costly testing effort associated with MCCS software and would reduce the probability of not finding an undetected bug.

A87-17. TITLE: Software Rework Metric (SRM)

DESCRIPTION: AMCCOM has a need to develop quantitative measures of software quality attributes of evolving software products, specifically in terms of reliability and maintainability. Unfortunately, these two quality characteristics are the most important and most visible to Government and industry software development.

The development of a software rework metric (SRM) as a measure of time, money, and effort needed to modify and correct software documentation, designs and code will make it possible to express reliability and maintainability characteristics of a software product. The metric will measure the effort, in terms of labor, travel, computer time, document processing, etc., that is incurred as a result of reworking a software product in any life-cycle phase that has been affected by a process and/or activity performed in a previous phase. This SRM measure must be based on previous program experiences, (i.e., corporate memory dependent) and must have the ability to expand its knowledge and/or data base relative to new data which is gathered from current system development efforts.

The SRM measure will provide program managers with a quantitative measure of the effectiveness of their software development methods and quality evaluation techniques.

A87-18. TITLE: Software Quality Analysis Extensions to the Common APSE Interface Set (CAIS)

DESCRIPTION: The DOD is committed to the use of Ada as the programming language to be used as the preferred Higher Order Language for all DOD projects in the future. The DOD has also specified the requirements of a group of interfaces to the Ada Programming Support Environment (APSE) known as the Common APSE Interface Set (CAIS) is designed to promote the source level capability and the portability of the Ada software development tools.

The analysis and assessment of software quality factors in contractor-provided software has been impeded in the past by lack of software design information and poor coding and annotating methods.

With the CAIS establishing a uniform language specification, language development environment, and human interface, there exists a need for a uniform series of Ada development tools for subsequent evaluation of code developed under the CAIS. These tools would:

- o perform ongoing design flowcharting
- o log changes/additions/enhancements to the source code
- o perform modularity and procedural checks
- o assess the sufficiency of annotation and remarks
- o perform other tasks which would be useful to assess and/or measure the quality of the software.

A87-19. TITLE: Software Test Hooks

DESCRIPTION: In today's software intensive weapon systems, it is required to provide software test points, or test hooks, which permit the diagnosis of hardware, software and/or operator induced faults. These hooks are to be identified early in the development of the software, utilized during testing, and provide support assistance to fielded systems. The need exists for a test hook design concept which answers the following questions:

- o What should a test hook consist of?
- o What features are available to be included in the test hook design concept, i.e., memory overhead, computation speed, timing, path execution, etc.? Which features would provide the most benefits?
- o Where should test hooks be placed?
- o How can test hooks tie into built in test (BIT)?
- o What will their impact be upon the timing of the program? Upon the program as a whole?
- o Should they be part of the production version of the software or should they be in a test version?

This test hook design concept should be generic in nature and not specific to a particular language.

A87-20. TITLE: Reducing Noise from Artillery, Tank, Mortars, and Small Arms

DESCRIPTION: Currently, the U.S. Army is faced with major ecological/ political noise problems (during worldwide peacetime training exercises) caused by the high noise levels of the firing and impacting of projectiles from artillery, tank, mortars and small arms. There is a need to have research done so as to lower the noise from both gun and projectile. Solutions can be generic or specific to gun, projectile, impacting schemes or geographic locations.

A87-21. TITLE: Ignition Concepts for Tank and Artillery Ammunition

DESCRIPTION: Develop ignition system for insensitive munitions. Low vulnerability propellants are being developed for several applications

including tank and artillery ammunition. These materials, by design, are more difficult to ignite.

Ignition systems are required which do not increase the vulnerability of the insensitive munition, but are effective igniters for the low vulnerability propellants. As an example, materials which produce excess oxidizer during combustion have been found to be effective igniters.

Design, construct and test an ignition system which may include new igniter materials that produce oxidizer rich combustion products, novel flame spread techniques via grain configuration and novel igniter positioning in the propellant bed. The new design is directed to the replacement of the bayonet primer in tank ammunition or base pad igniter in artillery.

A87-22. TITLE: Encasement of Stick Propellant for Artillery Charges

DESCRIPTION: Stick propelling charges currently are encased in a combustible case which presents ballistic problems. A preferred design from a strictly performance point-of-view is the non-cased charge. However, this is not practical because of field handling, storage and environmental concerns. Therefore, an alternate method, other than a cloth bag is desired which will provide the protection and consumability of the combustible and the performance of the non-cased charge. It is required to develop a design which can accomplish this goal.

A87-23. TITLE: Development of Combustible Case Test Procedures

DESCRIPTION: Develop test procedures which can be used for quality control testing of finished nitrocellulose-based combustible cases. The project will require a study to determine parameters important for end-use and the development of tests to address these parameters. As a minimum, the data required are mechanical strength, combustibility, storage life, and compatibility with propellant.

A87-24. TITLE: Polymeric Binder Compounds for Energetic Materials

DESCRIPTION: Studies have shown that the structural behavior and mode of failure of energetic materials has a marked effect on their ballistic performance. It has also been shown that changes in binder composition change the mechanical behavior of the material.

Investigations should be conducted on determining the binder composition which yields optimal properties. These studies should include mechanical and thermal effects, chemical compatibility and aging of the energetic formulation. Research is currently being conducted on thermoplastic elastomer and cellulose binder compounds.

A87-25. TITLE: Determination of Coating Thickness

DESCRIPTION: Techniques are to be developed which can rapidly determine

the completeness and thickness of coatings such as waxes or polyethylene on energetic materials which are usually nitro compounds.

A87-26. TITLE: Packaging of Army Ammunition

DESCRIPTION: The Packaging Division, ARDEC, is responsible for supplying packaging and packaging technology for all Army manufactured and supplied weaponry. In addition the Packaging Division is responsible for improving any Army packaging currently fielded, active or otherwise, in order to complement and enhance the logistic nature of the package. As part of this effort to improve packaging technology, the Packaging Division entered the initial stages of research and development in three areas.

The first of these three areas relates to packaging in a general way. Five programs fall under this heading, they are: Computer Aided Design/Engineering, Improved Cushioning Materials, Improved Gasket Materials, Improved Marketing Applications and Light Weight Materials. All five of these programs were designed to improve the overall package. The Computer Aided Design/Engineering was conceived to improve packaging designs. The final four are geared to improve the materials that will be used in the packaging design and in finding new materials.

The second area will be used to aid in the development of plastic containers now being developed in the product improvement area. This program will help in predicting the longevity of plastic containers after production.

The last area can be described as special projects. There are two projects in this area. They are enhanced Wood/NBC Protection and Foreign Exploitation. The Enhanced Wood program is an attempt to make wood NBC protectable. The Foreign Exploitation project is designed to exchange information on U.S. weapon packaging with our allies in an attempt to improve and speed packaging design.

A87-27. TITLE: Miniature LIDAR System for Standoff Detection

DESCRIPTION: Develop a LIDAR system using 4 frequency agile coaxially aligned CO_2 lasers, with an energy output (full width, half maximum at line 10P20) of at least 100 mj and a PRF of 100 Hz. Lasers should be tunable to at least 66 lines (min. FWHM energy - 30 mj) with a tuning rate of 100Hz. The system must have 9 in. collecting optics, state-of-the-art detectors, and be configured in a package of no more than 40 lbs. Lasers must be sealed, preferably with a passive catalyst to attain a life of 10 million shots per laser. The system must operate on a 28 volt power supply, and provide buffered 16 bit digital data (TTL logic) using an A/D rate of 20 Mhz, storing 4K words of data for each laser shot. This effort would support the Army's program to develop equipment for the standoff detection of chemical warfare agents.

A87-28. TITLE: Regeneration of Immunologically-active Surfaces

DESCRIPTION: Current Army requirements call for sensors to detect chemical and biological agents in a continuous or semi-continuous (repetitive) manner. Some of the sensors under consideration employ immunological recognition steps as the essential part of the transduction mechanism. A need exists to regenerate the "baseline" state of the antibody- or antigen-coated surfaces (that are an essential part of such sensors) in between successive analyses. This regeneration process would include antibody-antigen dissociation and perhaps the reloading of the surface with a labelled immunoreagent for a subsequent competitive reaction. While many different methods for dissociating antibody-antigen conjugates exist, most of these methods are effective only in certain applications. A method is desired that will have a more universal applicability and that, at the same time, will not denature the surface-bond immunoreagent. A parallel need exists for methods to regenerate baseline conditions of sensing surfaces composed of immobilized biological receptor proteins.

A87-29. TITLE: Production of Heat-stable Enzymes from Thermophilic Organisms

DESCRIPTION: There is great potential to improve the heat stability and shelf life of enzymes of interest in chemical/biological defense. These include enzymes (primarily oxidases and peroxidases) used in immunochemical tests for chemical/biological agents and toxins, as well as, catalytic moieties with potential as decontaminants. Commercially available, non-heat stable enzymes currently used could be stabilized by synthetic means, but only at great expense. Alternatively, an investigation of potential sources of naturally occurring heat stable enzymes from thermophilic organisms is desirable. Because thermophilic organisms exist in environments such as hot springs, they produce heat-stable enzymes naturally. The resulting baseline data would be used to conduct process engineering and scale-up work to prove out the production of these heat-stable enzymes by large-scale culture of these organisms.

A87-30. TITLE: Hydrophobic Treatments for Carbonaceous Absorbents

DESCRIPTION: The medium used in all military agent filtration systems for removal of agent vapors is ASC Carbon. This sorbent is a coal based carbon which has been impregnated with salts of copper, silver, and chromium. ASC Carbon has been demonstrated to provide excellent protection against a wide range of toxic chemical agents. However, the performance against some agents (those that absorb weakly on carbon) is adversely affected by high relative humidity in the filter challenge stream. It is desirable to alleviate the undesirable effect of relative humidity so that sorptive performance is high at all relative humidities. One approach might be a carbon treatment method which reduces the number of polar functional groups. This effort will require novel technology because the existence of the impregnants themselves likely contributes to the level of water absorption by ASC Carbon. This technology also has commercial application

to the manufacture of absorbents used in NIOSH approved industrial chemical vapor filters.

A87-31. TITLE: Conformal Thermoplastic Composite Materials

DESCRIPTION: Commercially available thermoplastic composite material forms possess two significant drawbacks: they are excessively boardy and have no tack. As a result, laminating compound curvature parts is more difficult and results in lower quality parts than with conventional epoxy prepreg construction. Innovative and novel product forms are required which solve these problems. These forms must be capable of providing all of the combination of fibers (graphite, Kevlar, glass) and different thermoplastic matrices of potential interest to helicopter primary structural applications. In addition, little or no degradation of material properties is desired compared with state-of-the-art prepregs. These materials should be equivalent to or lower in cost than conventional composite material forms. Demonstration of novel product forms applied to helicopter primary structure possessing compound curvature is necessary to achieve high quality thermoplastic components.

A87-32. TITLE: Repair Techniques of Fiber Optic Connectors/Cabling

DESCRIPTION: Repair of such hardware is now limited to bulky, skill-intensive techniques and hardware. Work needs to be conducted on developing repair concepts for field level maintenance of fiber optic subsystems, primarily the cabling and connector interfaces.

A87-33. TITLE: Measurement & Control of Static Electricity on Hovering Helicopters

DESCRIPTION: Electrostatic charges are generated on hovering helicopters by several mechanisms and result in extremely high residual voltages which can be hazardous during external cargo handling operations. The electric fields surrounding the helicopter can be quite complicated making sensing and control of the voltage relative to earth difficult. Innovative research is needed in the solution to this problem.

A87-34. TITLE: Improved Ocular Target Acquisition (IOTA)

DESCRIPTION: The improved ocular target acquisition concept is based on a set of infrared sensors that monitor an operator's eye position and orientation to determine direction of focus and generate the line of sight angular data required to effect target handoff or to accurately aim weapon systems. This concept has potential application as an improvement over helmet mounted sighting systems. By directly monitoring eye position and orientation to establish direction of focus, the sensors are unaffected by inaccuracies resulting from the operator's head motion and helmet shifting which are inherent in helicopter helmet sighting systems. Accordingly a 4 to 1 improvement in aiming accuracy is anticipated.

Under this effort breadboard hardware/software will be fabricated and integrated into a suitable helicopter cockpit simulator in order to evaluate performance and verify potential application as a helicopter sighting system.

A87-35. TITLE: Multi-rotorcraft, Multi-threat air-to-ground Engagement Simulation

DESCRIPTION: Develop, verify and validate a micro-computer based simulation of air-to-ground combat engagements between rotorcraft flying in the nap of the earth and ground based missiles and guns having acoustic, optical, infrared, and radar sensors. Multiple rotorcraft and multiple threats should be able to operate autonomously or in teams. Effects of terrain on intervisibility are required. The simulation is needed to evaluate the benefits of emerging rotorcraft technologies.

A87-36. TITLE: Air-to-Air Combat Engagement Analysis Utilizing Terrain Shielding

DESCRIPTION: Conduct investigation of the Family of Light Helicopters in a one-on-one air-to-air combat environment. The investigation is to include the dynamic characteristics of air vehicles (6 degrees of freedom), weapon characteristic sensors and sensor cueing, active and passive counter measures, counter-counter measures, target selection and target handoff, and terrain shielding.

A87-37. TITLE: Ceramic Component Non-Destructive Testing Technology

DESCRIPTION: There is an increasing use of silica and alumina based ceramic material systems in gas turbine components. The ability to detect a good component from a materials standpoint is at best limited. This project would pursue new and innovative approaches to determining a good ceramic component from bad due to material defects.

A87-38. TITLE: Advanced Recuperator Technology

DESCRIPTION: The need for advanced methods to recuperate lost energy in small flight weight turboshaft or compound cycle engines is increasing with higher operating temperatures. This project would investigate novel approaches to exchanging the energy and getting it back into the cycle, to increase the overall cycle efficiency while minimizing performance penalties due to increased weight.

A87-39. TITLE: Titanium Webbed Gearing

DESCRIPTION: Investigate techniques for bonding steel rims to titanium gear webs. The bond between steel and titanium will be evaluated both destructively and non-destructively to determine success of process. Utilizing titanium webs could save 20-30% of gear weights.

A87-40. TITLE: Rotorcraft Advanced Transmission Concept

DESCRIPTION: Investigate the potential of a Squirm drive system for possible use in a rotorcraft transmission of 500 shp size. Conduct feasibility study, calculate transmission efficiency and life. Fabricate prototype for testing at the Army Propulsion Directorate.

A87-41. TITLE: Digital Beam Forming (DBF) Radar

DESCRIPTION: In any radar employing an array receiving antenna, signals from a number of antenna elements are appropriately weighted and combined to form various antenna beam outputs. Digital beam forming (DBF) denotes the formation of these beam outputs by digital computer. The elemental signals are sampled and digitized, then weighted and combined as "numbers" in the computer. The stream of numbers thus formed present the signal that is seen by a given antenna beam. Changing the weights applied to the digitized samples changes the direction and/or shape.

Now by providing the proper analog "pre-processing" at each element just prior to the A/D conversion, the converter dynamic range (number of "bits") can be significantly reduced. This reduces the size, complexity, power consumption, and cost of the converters, and reduces the number of parallel lines needed to link each converter to the central processor. Proposals to explore this line of research are of interest, including the consideration of design and mechanization of appropriate integrated circuits, and their implementation as part of a DBF receiver. Signal processing architectures and designs which take maximum advantage of DBF technology, including VHSIC and VLSI hardware and advanced FFT algorithms will be considered.

A87-42. TITLE: PIN Diode Limiter Dynamics

DESCRIPTION: PIN diodes are mounted as limiters in shunt across TEM transmission line to protect microwave receiver components from damage by high power microwave pulses. They are characterized by a finite burnout threshold and spike leakage when subjected to fast rise-time pulses. Theoretical and experimental work is needed to characterize these burnout and spike leakage properties. There are many life-times associated with semiconductor devices, but none of them describes directly how PIN diodes perform as limiters.

Theory and experiment are needed to find ways to measure the important parameters of PIN junction diodes wherein the electrical parameters measured are traced directly to the physical parameters of the structure of the junction. When this work is complete, a design engineer using a PIN diode should be able to measure the diode in a non-destructive test and predict what its spike leakage and damage threshold will be. A PIN junction manufacturer should be able to specify the physical process used in fabricating it and know what performance it will provide. System designers should be able to know the theoretical limitations of PIN diode limiters.

A87-43. TITLE: Safety & Reliability Theories for Electronic Safing and Arming

DESCRIPTION: The Army needs reliable theories for the safety and reliability of electronic S&A's which will have in-line (stationary) explosive trains. The objective of these efforts is to formulate such theories with the emphasis on logic-controlled safety and firing systems. The desired starting point for development of S&A system analyses is a study and critique of the assumptions, methodologies and conclusions found in a recent report related to electronic S&A's. This report is "The Worst Case Mathematical Theory of Safe-Arming" by Dennis A. Silvia; Technical Report ARBRL-TR-02444 (ADA143789). Any study and critique of this report should highlight areas of agreement and disagreement with the methodology presented. In addition, reasons for disagreements and resulting corrections are to be substantiated and explained. This effort should be conducted with the intent of (1) extending the critique where needed and making initial theoretical applications of the "new" theories using some of the more likely threats and (2) continuing the theoretical application efforts and preparing a test plan for the more critical threats, including the required test equipment and methods.

A87-44. TITLE: Total Dose PROM Test

DESCRIPTION: The object of this program is to measure the total ionizing dose failure on either an ultra violet erasable programmable read only memory (EPROM) IC or erasable programmable read only memory (EEPROM) IC.

The IC is to be selected by the contractor with HDL's approval. The IC will be a current high-memory-density (greater than either 16K for an EEPROM or 64K for an EPROM), metal-oxide semiconductor (MOS) IC with scaled down geometry (less than 3.5 microns gate length) and will have a good potential for military usage. It will be a US manufacturer's part made with nonradiation hardened process. The device tested will not have been tested before (no existing test data).

Testing will be done at a Cobalt 60 facility in the dose range of 50-200 rad(Si)/s. Alternatively, a linear accelerator (LINAC) with an electron energy greater than 10 MeV delivering a peak dose rate of less than 5×10^{6} rad(Si)/s may be used. If the LINAC is used, the number of pulses per second and the peak dose rate will be chosen to deliver an average dose rate of 50-200 rad (Si)/s.

The test shall be a functional test (all memory locations checked) with checkerboard test patterns used in a manner as to insure that any bad address or data line will be detected as an error. Due to annealing effects, the proposal acceptance will be weighted toward continuous device testing as opposed to step testing. For continous testing, the time between an error's occurrence and detection should be less than 2 seconds. However, if step irradiations are used, the device will be powered during irradiation and unpowered afterward with all pins grounded until tested.

The irradiation steps shall increase by a 5 times multiple of the previous step with details being worked out with HDL. The time between irradiation and the end of the functional test shall not exceed 5 minutes. The minimum testing shall be a read verify cycle for an EPROM. At least 25 parts will be tested preferably 5 samples each from 5 lots and, if there is more than one American supplier of the part, the sample size shall be 15 samples from each supplier, 5 samples for 3 different lots.

The contractor shall supply everything necessary to accomplish the test, pay for radiation facility, and supply HDL with a written report describing as a minimum any problems encountered, the test setup, test procedures, the test conditions, the test results, and the contractor's conclusions. If the contractor chooses to use the HDL Cobalt 60 facility, this shall be supplied as GFE with three month scheduling notice.

A87-45. TITLE: Electromagnetic Field Coupling to a Wire Inside a Metallic Enclosure

DESCRIPTION: Novel ideas and approaches are solicited to understand and predict the coupling of pulsed electromagnetic fields to a thin wire located inside a metallic enclosure. The enclosure is a thin walled body of rectangular shape. The internal electromagnetic fields are produced by the diffusion of the external fields into the interior. The wire is assumed to be in electrical contact at both its ends with the cavity interior wall surfaces. It spans a pair of opposite wall surfaces. The external electromagnetic field has a fast risetime (a few nanoseconds) and a relatively long delay time (a few microseconds). Thus there is significant frequency content in the region from dc to 100 Megahertz. The cavity size is not small compared to the wavelengths in the exciting field. The description of the coupled transients, both voltage and current, on the internal wire is required. Of particular interest are how these transients would change due to the variable parameters of cavity size, external field pulse risetime, decay times and polarization.

A87-46. TITLE: Multistatic Radar Technology

DESCRIPTION: Development in this area should examine approaches, concepts and related technology needs addressing multistatic radar issues. Issues of interest include methods of achieving coherency; beam, pulse, and burst chasing processing techniques; antenna beam forming approaches, etc. The study should emphasize items such as target and clutter processing, plus techniques unique to multistatic systems.

A87-47. TITLE: Micro-scale, Active Threshold Accelerometers

DESCRIPTION: Electronic fuzes for various munitions use simple G-switches for sensing launch acceleration, spin forces, and forces due to target impact. Current G-switch designs are large assemblies of several mechanical parts. In keeping with the trend toward miniature, low-cost electronic circuit assemblies in fuzing, G-switches that are physically compatible with integrated circuits need to be developed. Nominal

requirements for such switches are: manufacturable using integrated circuit related techniques, size on the order of 10 cubic mm max and a few cubic mm desired, costs on the order of $0.20 each in quantities of 100K+ units per year, designs for integration with circuit chips and designs to stand alone in surface mount or hybrid circuit component fashion, voltage switching capability in the range of millivolts to 5 volts, various designs for threshold closure levels in the range of 20 G to 20,000 G, and ability to resist closure under vibration levels to 15 G.

A87-48. TITLE: Passive Type Micro-scale Self-integrating Accelerometer (Velocimeter)

DESCRIPTION: The objective is to design, analyze and evaluate concepts for a device to sense projectile and rocket acceleration that will change the state of its output only if the change in velocity produced by the acceleration pulse exceeds a critical level. This sensing and "information processing" function must be performed without external electric power except as discussed below. The sensor is not intended to be an instrumentation grade device; a tolerance of +20% on the velocity change shall be the design goal. This self-generating (passive) type sensor could, for example, generate electrical energy proportional to the change in velocity and store it for a least 200 ms, after which it could be interrogated by a fuze's battery powered logic circuits. Fuze power will be available within 200 ms after the start of the launch acceleration. The sensor need not be electrical/electronic in nature but a switch closure output or equivalent would be required for an otherwise all-mechanical device. The acceleration pulses to be measured by the sensor are those associated with firing of projectiles and rockets. Peak accelerations will range from about 800 G to 40,000 G; the pulse duration will range from about 4 to 40 ms; and the velocity change will range from about 250 to 3500 FPS. The sensor will be exposed to angular acceleration coincident with the linear acceleration if used in fuzes for spin stabilized artillery projectiles. The effect of such angular accelerations on velocity change measurement shall be accommodated within the +20% tolerance goal. The sensor will also be exposed to shocks produced during transport and handling. These shocks can be expected to have any duration and levels to 100,000 G, but the velocity change associated with the shock be designed to survive handling shocks (and retain its "calibration") and not indicate a valid launch. Similarly, the sensor shall not indicate a valid launch (velocity change) under swept sine and random vibration inputs from 50 to 2,000 Hz at 10 G amplitude. The acceleration sensor and associated signal processing system should fit in a volume on the order of 1 cc or less. This volume should include any protective packaging, or shock mitigating material required. The preferred form of mounting the components is by surface-mount PC board technology. Ultimately, the acceleration sensor must meet all performance requirements over a temperature range of -40F to 140F and not be adversely affected by a storage temperature range of -65F to +165F.

A87-49. TITLE: Fuze Air Flight Sensor for Safety and Arming Projected Munitions

DESCRIPTION: A method or device is needed which will sense air speed or air flight for tube-launched munitions. The required device is a sensor which will transduce some aspect of the air flight "environment" into an analyzable signature. Approaches which transduce structural vibration or strain waves, which result from boundary layer excitations due to air flow, are currently anticipated. The sensing device will be combined with a processing circuit, whose design is the subject of another task. Together the sensor and circuit will be able to generate an air flight signature and discriminate handling environments and flight speeds of less than 60 fps from flight speeds of 200 fps up to 4000 fps. The output signal will be used in safety and arming of munitions. The sensor may include temperature compensation in its design, but if not, the temperature compensation can be provided as part of the associated processing circuit, which will also provide logic which recognizes preselected characteristics of the flight signature. The task is to design a sensor which: (1) will produce an air flight signature for the given speed range, (2) can be contained in the fuze body and which preferably can be mounted on an IC board, (3) does not require ingested air, (4) is small (microscale is the goal), (5) is battlefield rugged, (6) will be inexpensive to produce in volume, and (7) will work to altitudes of 15,000 ft and at temperatures from -40F to 140F. Post-launch power will be available for operation of the sensor.

A87-50. TITLE: Fuze Air Flight Signature Processing for Safety and Arming of Projected Munitions

DESCRIPTION: A signal processing technique and circuit is needed to analyze an air flight signature and to produce a logic output for safety and arming decision making. A sensor is being designed, as part of another task, which will transduce some aspect of the air flight environment of a projectile and produce an analyzable signature. Assume that this signature corresponds to structural vibrations induced by aerodynammic excitations in the boundary layer. Assume also that the output from one or two sensors at different locations may be available in the fuze. Design a circuit process that will discriminate handling environments and flight speeds less than 60 fps from flight speeds of 200 fps to 4000 fps. The circuit should provide processing and logic whereby only pre-selected characteristics of the flight signature are accepted as part of the determination of the flight condition. These characteristics might include frequency, amplitude, uninterrupted duration, and other characteristics of the signal. The circuit board area of less than 1 in ^{2}.

A87-51. TITLE: Fluidic Amplifiers

DESCRIPTION: The objective of this program is to increase the performance capabilities of fluidic laminar proportional amplifiers (LPA's) in the frequency domain when the control signal of interest is applied to a single control port. During the mid-1970's, scientists at the Harry Diamond

Laboratories (HDL) developed second-generation, laminar-flow fluidic components. In the absence of flow noise in the laminar regime, laminar fluidic devices can detect and amplify extremely small pressure and flow signals. The basic building block of second-generation fluidics is the laminar proportional amplifier (LPA). A standard LPA configuration has been in use for many years now at HDL; its geometry is the result of a combination of analytical and experimental investigations. The standard LPA was optimized for use as a differential amplifier; i.e., it operates on those signals applied differentially, in a push-pull fashion, to both controls of the LPA. There has been little or no effort to design an LPA specifically for the case where a single control signal is introduced into only one input. As an example, in a fluidic public address system, the acoustic input voice (AC pressure) signal enters one control of an LPA, while the opposite control is intentionally grounded.

The proposed program would investigate and develop new LPA configurations that are specifically designed to accept nondifferential AC inputs signals; i.e., an LPA with only one active control port. Such newly-designed LPA's would then be used as the first stage (preamplifier) in an LPA gain block. The rest of the gain block would be made up of standard LPA's. Initial examination of some very preliminary designs of a concept for the new AC LPA already suggest that a single input LPA would have higher frequency response and better gain that the standard differential LPA. This overall task will require both an iterative parametric study and an analytical study of critical dimensions to identify the optimum geometry. Among the parameters to be investigated are the control nozzle width, the setback of single active control, and the splitter distance.

Subsequent research would address overall fluidic circuit design techniques to improve dynamic performance (e.g. to obtain a flat, or at least linear response over a specific handwidth).

A87-52. TITLE: Optical Protection from Nuclear Thermal Energy

DESCRIPTION: There is a need to prevent high intensity thermal energy (radiated from the fireball of small nuclear weapons) from entering a variety of optical devices. A number of photochromic and electrochromic techniques, which have been developed for other purposes, might be applicable for thermal protection by rejecting the high intensity nuclear thermal energy (which has approximately the same spectrum as sunlight) without significantly interfering with the normal performance of the optical devices before and after nuclear exposure. A survey should be conducted to determine the relative amount of protection afforded by the various techniques as well as their cost, availability and compatibility with militarized optical devices. An analysis should also be done to determine if the protective device could operate in the associated non-nuclear environments (neutrons, gamma, blast, EMP). The most promising techniques should be developed and demonstrated in simulated nuclear weapon environments.

A87-53. TITLE: EMP Environment Prediction for Collimated Sources

DESCRIPTION: Develop theoretical framework and computer code implementation of a means of predicting the EMP produced by collimated sources. Techniques are needed to evaluate the possible impact of EMP environments produced by collimated gamma sources and by collimated Compton electron sources in the above the atmosphere. The first step is to predict the EMP environment (electric and magnetic fields) spatial variation and time history for a variety of possible configurations involving collimation of the gamma or Compton electron sources in the vicinity of the gamma source. This is an important potential area of concern to electronic system developers at a time when migration of weapon systems into the upper atmosphere and near space is contemplated.

We would like a contractor with previous experience in EMP environment prediction and code building and with a strong theoretical capability to handle new problems in EMP prediction.

A87-54. TITLE: Void Sensor for Artillery Fuzes

DESCRIPTION: Develop a concept for a new method for sensing passage of an artillery round into a void after impact with a masonry or concrete target. The device may be electrically powered and must be small enough to be integrated into the body of the safety and arming device. The void sensor must be cost compatible with the rest of the fuze. An artillery fuze using the void sensor could be expected to cost about $65 in production. Gross body decelerations of 5000 to 15000 g's with shocks to 100,000 g's can be expected during passage thru the target. When a void is sensed after passage through a target the sensor must provide a switch closure or electrical signal to initiate the S&A device.

A87-55. TITLE: Adaptive Control, Nonlinear Multi-axis Vibration

DESCRIPTION: The objective of this program is to investigate concepts and techniques to achieve stable control of field vibration signatures reproduced on state-of-the-art, 3-axis vibration simulator when operating in highly unstable dynamic regimes (1800-2000 Hz). The deliverable is a research report containing models, methods, and tradeoffs.

Nonlinear dynamic behavior of the 3-axis vibration simulator in the high modal density regime (1800-2000 Hz range) causes control instability which leads to system shutdown. The active control method employed, which sets shaker gain based on predetermined drive axis impedance and cross-axis coupling effects, is based on stationary linear control theory. This theory does not account for the nonlinear effects of frequency and time inherent in the system's spatial (3x3) transfer function. Accumulation of control error due to nonlinear effects may exceed 20 dB and cause 180F phase shift (within a single 5 ms loop) leading to control instability, particularly in the high modal density regime. New adaptive control models/concepts must be investigated to allow for continuous corrections to

the spatial transfer function based on frequency, time, and excitation level. The model(s) must interface with existing digital controller and control algorithm. Concurrently, the research will establish the feasibility of using 3D animated color graphics to assure spatial compliance of nonstationary random vibration in real time.

A87-56. TITLE: Zinc-Air Fuze Power Supply

DESCRIPTION: Study the zinc-air electrochemical system as applied to power sources and determine its suitability for application to a fuze power supply. Packaging size, gun ruggedness and electrical capabilities will be examined and prototype units will be constructed and evaluated.

A87-57. TITLE: Magnetic Gradient Sensor

DESCRIPTION: Design and fabricate a three-axis magnetic gradient sensor to operate over a 20 to 1000 Hz frequency range. The sensor will be capable of sensing a gradient from .25mOe/foot to 200mOe/foot. It should have three analog output voltages which are linear over the full specified range. The outputs shall have a noise level equivalent to less than .1mOe/foot over the whole frequency band. The sensor shall be shielded from electronic radiation and fit in a 4" x 4" x 4" cube. The sensor shall be mounted to withstand a missile environment of 10G's vibration and 100G's set back. The sensor shall draw less than 100mA from a 28V battery.

A87-58. TITLE: Magnetic Field Sensor

DESCRIPTION: Design and fabricate a three-axis flux gate magnetometer. The magnetometer will be able to sense magnet field varying from D.C. to 1 KHz. The sensor shall have a 4Hz wide dynamic notch filter that attenuates the strongest interference signal in the range from 20 to 60 Hz with at least 40 dB attenuation. The sensor will be capable of sensing a field from 1mOe to 1Oe with at least .1% linearity and less than .1mOe noise over the whole frequency range. It should have an analog output for each axis. This magnetometer shall be shielded from electronic radiation and fit in a 3" x 3" x 3" cube. The sensor shall be mounted to withstand a missile environment of 10G's vibration and 100G's set back. The sensor shall draw less than 100mA from a 28V battery.

A87-59. TITLE: Commercial Emergency Fuze Power Supply

DESCRIPTION: Assemble commercially available active batteries and/or cells into packages capable of surviving gun fire, i.e., capable of withstanding the dynamic gun characteristics of high "g" setback and high "g" spin. units will be configured to be exact size and shape replacements for the military item and which, in case of national emergency, could be incorporated into fuzes until such time as production rates of the military version will no longer require their use.

A87-60. TITLE: Numerical Approaches to the Solution of Electromagnetic Coupling/Scattering Problems

DESCRIPTION: Develop new and innovative techniques for the solution of complex electromagnetic coupling and scattering problems. In particular the Army is interested in the development of techniques that can substantially reduce the computer run times and size limitations imposed by extant numerical approaches (e.g., NEC MOM, 3D finite difference code). Main concern is focused on the interaction of the nuclear produced electromagnetic pulse (NEMP) with objects on/in/over a real earth. The interaction may take place within, near, or distant from the "source region", which permits innovation in the time variant and non-linear regimes as well as the purely linear regime. Non-linear effects such as corona and arcing are of interest. Environments other than the NEMP that are of interest include pulsed microwave fields, MHD-EMP, and electromagnetic environments collaterally produced by SDI weaponry.

A87-61. TITLE: Low Cost Miniature DC-DC Converter

DESCRIPTION: The Army is presently developing electronic safety and arming (S&A) systems for use in low cost artillery and missile applications. One vital part of the system is the dc-dc converter which charges an energy storage capacitor. The nominal requirements for this dc-dc converter are: operates with an input voltage of 20-40 volts, charges a 0.068 F capacitor to 3kV in 0.5 seconds maximum, provides adequate reliability (depending on specific application), while charging draws an average current of 50 mA or less with peaks of 200 mA maximum, has an inactive operating mode which draws 10 mA or less, is compatible with a high acceleration (up to 30,000 G) launch environment, fits in a max space of 0.4 cubic inch with no dimension greater than 1.30 inch and operates over the temperature range of -40 to +70C. One deviation from these requirements which is acceptable is to use numerous available integrated circuits and discrete devices to implement a design which ultimately could be integrated into monolithic/hybrid device which is compatible with the packaging requirements. We would like a contractor to design such a dc-dc converter, fabricate prototype converters, verify the viability of the design through analysis and tests and provide prototype converters to HDL for further evaluation.

A87-62. TITLE: Low Cost Miniature Energy Storage Capacitor

DESCRIPTION: The Army is presently developing electronic safety and arming (S&A) systems for use in low cost artillery and missile applications. One vital component is an energy storage capacitor for use in the system. The nominal requirements for this capacitor are: stores 150m Joules at 2-3 K-volts with adequate reliability (depending on specific application), reliably interconnects to a low inductance flexprint assembly, provides a discharge peak current of 3000 A minimum with a maximum risetime of 50 ns, is compatible with a high acceleration (30,000 G) launch environment, is cost competitive with extended foil plastic film and low cost ceramic

capacitors, fits in a max space of 0.4 cubic inch with no dimension greater than 1.3 inch, and operates over the temperature range of -40 to +70C.

Extended foil plastic film capacitors with a dielectric stress of 2 KV/mill will meet all of these requirements except size. Some known ceramic capacitors have the potential for meeting most of these requirements but use precious metal electrodes and are far too expensive for these applications. What is required is a new generation of low cost capacitors which make better use of the intrinsic properties of plastic film, ceramic, or possibly other dielectric materials than existing capacitors. Both plastic film and ceramic materials have the potential for development into a capacitor which meets the stated requirements. We would like a contractor to design such a capacitor, fabricate prototype capacitors, verify the viability of the design through analysis and tests and provide prototype capacitors to HDL for further evaluation.

A87-63. TITLE: Low Cost Miniature High Voltage Switch

DESCRIPTION: The Army is presently developing electronic safety and arming (S&A) systems for use in low cost artillery and missile applications. One vital part of these systems is a high voltage switch. This switch stands off the voltage on an energy storage capacitor and, when triggered, efficiently transfers the energy in this capacitor. The nominal requirements for this switch are: stands off 3 KV, when triggered passes a circuit of 3000 amps with a risetime of 50-n seconds, has a voltage drop of no more than 300 volts at a current 3000 amps, has a volume of 0.05 cubic inches or less, is low cost (comparable to commercial grade small signal transistors), has triggering requirements that are compatible with miniature low cost systems, operates over a temperature range of -40 to +70C and is not degraded under 20 years of military storage conditions. Other desirable characteristics are multifunction capability and physical characteristics that would allow the switch to be included in a flexprint assembly. Three candidate technologies have been identified so far for this application: spark gap switch (modular and printed circuit) avalanche diode (semi conductor-triggered switch), and explosive/plastic film switch. We would like a contractor to review the different technologies for this application, design a switch and trigger circuit which meets the stated requirements, fabricate prototype switches, verify the viability of the design through analysis and tests and provide prototype switches and trigger circuits to HDL for further evaluation.

A87-64. TITLE: Code Reader for Artillery Fuze Setting

DESCRIPTION: The task is to develop a code reader for an artillery fuze. The code reader will read bits from the interior of a stack of three rings with a 1.240 inch inner diameter. The top ring will have 17 circumferential positions and be .200 inches tall, the middle 10 positions at .140 tall, and the bottom 20 positions at .200 tall (yielding over 3000 discrete settings). The output from the code reader should be digital, whether in the form of switch closures or active signals. The code reader

can be supplied with power from the fuze battery. The unit should be as small as possible and be able to withstand 30,000 G's axial and 500,000 rad/sec^2 radial acceleration at gun launch. The unit must also be very low cost due to the low unit cost of artillery fuzes.

Current code readers are eight-channel mechanical switches reading one ring which is .500 inches tall with 80 positions around the circumference. Very small switches and optical devices are only two possibilities. Modifications to the rings may be made, such as etching electrical patches, printing optical reflectors, and embedding materials to be used by a non-contract (hall effect or inductive) sensor.

A87-65. TITLE: Direction Sensor for Artillery Fuze Setting

DESCRIPTION: The task is to develop a small device to determine the direction of rotation of a setting ring on an artillery fuze. The ring would have approximately a 1.5 to 2 inch i.d. and be .125 to .250 inches thick. The detection would take place from the inner surface of the ring. The detector must be very small, volumes of under .080 cu. in. would be desirable. Low unit cost is also very important due to the low unit cost of artillery fuzes. The detector must also be able to withstand launch from an artillery weapon, an acceleration of 30,000 G's and 500,000 rad/sec^2 radial acceleration.

The detector should be very low power and have a digital output. Detection may be through mechanical, optical, or other non-contact means. Non-contact methods, i.e., low power hall-effect, capacitive, or inductive means, would be desirable. The detector should have a resolution of 20 possible state changes per revolution of the ring. The detector circuitry should be as simple and compact as possible, and may be considered separate from the actual detector volume. Modifications to the ring may be made, such as etching electrical contact patches, printing optical reflectors, and embedding materials to be used by a non-contact sensor. Any modifications to the rings must also follow the same ruggedness guidelines and be inexpensive.

A87-66. TITLE: Liquid Crystal Display Illumination for Night Use

DESCRIPTION: Develop a low power illumination concept for thin film plastic liquid crystal displays. The LCD has a thickness of .015 in. and a width of .75 in. and is formed into a arc of 120 degrees at a radius of 1 inch. This display will be mounted on the surface of an artillery fuze and will have minimum intrusion into the fuze body. The concept must be cost compatible with a total fuze cost of $65 in production. Electrical and non-electrical illumination should be considered.

A87-67. TITLE: Dual Purpose Explosive Output for Artillery Fuzes

DESCRIPTION: Current fuzes for cargo dispensing projectiles are designed to have their output lead charge initiate a special expelling charge in the

projectile. However, these fuzes can also be fitted with a high explosive (HE) booster pellet and used to initiate HE burster type projectiles. Since they fit both types of projectiles, the fuze with lead only can be mistakenly used on HE projectiles and this results in a dud. Furthermore, the need for a booster on HE projectiles means two different types of fuzes must be fielded where their only difference is the presence of the booster. A preferable situation is one in which a single fuze could be used on either type of projectile without the need for special booster handling procedures in the field. The objective of this research is to devise a new lead charge and explosive interface configuration that can function to properly initiate both HE and cargo type projectiles (propellants, etc.). The current lead charge output must be made more powerful so that it can initiate HE warheads over the long gap presented when the traditional booster pellet is omitted from the fuze/projectile interface. However, the charge must not be made so powerful that it vents the pressure cavity sealing required by expulsion type projectiles. Special flyer plate or fragment output from the lead charge may be required and the solution must be compatible with the design constraints of the explosive train in future artillery projectile fuzes.

A87-68. TITLE: EW Vulnerability

DESCRIPTION: The US Army has an extensive program designed to stress developed systems and systems under development to electronic warfare (EW) environments. The objective is to establish or determine each system's performance limitations or vulnerability when exposed to existing and/or postulated EW threat environments. The EW environments consist of active and passive electronic countermeasures (ECM). EW vulnerability can be reduced by the incorporation of electronic counter-countermeasures (ECCM) into the weapon system to harden it against hostile EW. Electronic support measures (ESM) are an integral part of the total EW picture. ESM is used to detect, locate, and identify systems on a modern battlefield. The Army EW vulnerability assessment (EWVA) program seeks technological advances in the ECM, ECCM, and ESM areas as well as innovative techniques in the determination of system EW vulnerability.

An innovative technique in EWVA that needs to be addressed is the use of artificial intelligence (AI). The application of the AI should be directed toward the structuring of the EWVA data base to support AI computer-aided EWVA's. This computer-aided EWVA technique will permit the necessary cost control of out-year EWVA programs. Unique and more efficient approaches in the establishment of the systems' EW vulnerability are required for the theoretical, laboratory, and field investigations. In addition, the Army's EWVA program requires applicable advances in the electromagnetic (EM) technology areas involving the following regions of the EM spectrum: acoustic (A), millimeter wave (mmw), infrared (ir), optical (O), and ultraviolet (UV). The trend is to use three or more of these regions in a weapon system which categorizes the system as having multispectral capabilities. Technological advances that can broadband the ECM, ECCM, and ESM areas are also required.

A very broad base of scientific knowledge exists in the areas of magnetic fields. However, there are limitations to their applications because of such things as limited detection range capabilities and low field densities, etc. These have limited the uses and applications of magnetic fields for effective CM and ESM use. There is a need to develop magnetic field applications that can be used to complement existing ESM techniques across the spectrum. Multispectral sensor technology needs to be developed to permit simultaneous operation across RF, mmw, ir, O, and UV wavelengths.

For ECM advancement there are requirements to address advanced passive ECM, low observables, and smart munitions ECM techniques. The advanced passive ECM techniques are required for multispectral ECM environments. The tailoring, for ECM purposes, of the multispectral signatures of military targets such as missiles, aircraft, ground vehicles, artillery, and high value assets should be addressed. Smart munitions ECM techniques must be as broadband as possible to minimize the costs of applying them to a wide variety of munitions currently undergoing development.

ECCM advances required are for electro-optical (EO) devices. These ECCM techniques should be used to reduce the ECM effects of lasers against EO devices. The importance of very fast optical switches/filters that can respond to the variable postulated wavelengths of hostile threats should be stressed. Emphasis should be on ir, television (TV), nightsights, UV systems, and the human eye.

There is a trend in the development of new weapon systems based on directed energy technology (high power microwave (HPM), high energy laser, particle beams, kinetic energy weapons, etc.). This places requirements for advances in EW techniques to counter their effects/sensors/fire control systems. These sensors include both active and passive systems. The sensors are expected to operate in the microwave through UV regions of the EM spectrum. Advances in EW techniques are required to defeat these sensors to include search acquisition, track, discrimination, fire control, and kill assessment. ECCM technology development for hardening against directed energy weapons (DEW) will be required. Near term ECCM technology for protection of U.S. systems against high energy lasers and HPM should be addressed. Far term efforts are required to develop technology for hardening against particle beams.

An important area in assessing the EW vulnerability of systems is the ability to perform accurate EW signature measurements across the EM spectrum. Advances are needed in signature measurements that will not only provide comprehensive data with the required accuracy, but will also minimize the time in accomplishing the measurements; i.e., minimize cost.

A87-69. TITLE. <u>Satellite Analyses for Special Forces Operations</u>

DESCRIPTION: Applications and techniques for utilization of meteorological satellite data are required for use in providing weather intelligence to the battlefield commander involved in Special Forces Operations.

Consideration is to be given to data acquisition, conversion of the data into intelligence relating to environmental effects on operations and equipment, and data displays.

A87-70. TITLE: Model of Port Scatter from Lasers

DESCRIPTION: The contractor will develop a model of the angular scattering pattern from the port optics of laser sources. The model will describe scattering from lasers both with material windows and with cassegranian mirror structure. Material imperfections surface defects, and the presence of dust will be considered.

A87-71. TITLE: Mesoscale Environmental Nowcasting for Tactical Army Operations

DESCRIPTION: Techniques and methods suitable for implementation on tactical computer systems are required to provide maximum weather and environmental intelligence from limited battlefield observations of atmospheric and other environmental parameters. Analysis and display techniques are needed to provide a means of displaying current weather conditions over a limited tactical area (typically $<$ 100 km square) based on various ensembles of environmental data sources and knowledge of terrain and surface features.

A87-72. TITLE: Knowledge Representation for Weather Classification

DESCRIPTION: The use of Artificial Intelligence to determine weather effects requires that efficient schemes for knowledge representation and knowledge acquisition be developed. Innovative projects to develop and test such schemes are needed.

A87-73. TITLE: Non-Emitting Device to Measure Visibility along a Path Length

DESCRIPTION: There exists point source visibility measuring devices that do not emit RF, light, or other radiation while they measure atmospheric turbidity, extinction coefficient, or some other atmospheric parameter which can be correlated to visibility at that single point of measurement.

A87-74. TITLE: Interferrometric High-Pressure Sensor

DESCRIPTION: A high pressure, wide bandwidth sensor is required for many research measurements in the ballistic community. The basic concept is to use a monolithic Fabry-Perot etalon constructed of a material such as sapphire at the end of a optical fiber. Physical size of the etalon should be limited to maximize response to transient pressure pulses. A miniature monolithic single frequency Nd:YAG laser pumped by a diode laser would be located external to the pressure cell. By generating interference fringes with the etalon inside the pressure cell, changes in pressure are detected by fringe shifts. In order to obtain sufficient signal-to-noise ratio

during transient events, the laser should operate at power levels of 100 milliwatts or greater and coupling in and out of the system should be done efficiently. Detection can be done with diode arrays (e.g., Reticon or CCD arrays) or Commercial arrays are adequate for demonstration purposes; in application to transient events a developmental rapid scan array should be available if required. The fiber optic should be mounted in a conventional or easily adapted mechanical fitting adequate to seal the required pressures.

A87-75. Instrument for Calibrating Thermocouple Thermometers in High Temperature Gas Flows

DESCRIPTION: A requirement exists for an instrument which can provide routine calibration of small, bare-wire thermocouple in flows of hot gases. The instrument would comprise two separate functions: a means for producing a hot flowing gas over a range of temperatures and velocities (all at atmospheric pressure) and a means for accurately determining the temperature and flow velocity produced. The former might consist of a flat-flame burner capable of providing a region (on the order of a centimeter) of uniform temperature. Temperatures and flow velocities might be selected by choice of fuel gas and equivalence ration and/or use of diluents. Flow velocity might be measured by monitoring the cold gas flow into the burner and combining this data with the temperature of the flow in the calibration region. The most difficult part is the measurement of the temperature in the calibration region. Flow temperatures of at least 1700 C are required (based on using Pt thermocouple) and up to 3000 C desirable (based on tungsten thermocouple). Minimum flow temperature should be at most 800 C with somewhat lower temperatures desirable. Since the instrument is to be used as a calibration standard, the error of temperature measurement should be of the order of 0.25%. Such accuracies can easily be obtained by optical fiber thermometry, if proposed, must be both reliable and "turn-key". It is further desired that the instrument be as compact and mobile as possible.

A87-76. TITLE: Radiation Contour Synthesizer/Detector System

DESCRIPTION: A system is needed for training purposes to artificially generate and simulate the measurement of nuclear radiation-like contours, in the "absence" of the radiation. The task is to develop (proto-type) and demonstrate a radio-frequency type battery powered sender-receiver system operable over semi-level terrain, within 3 1/2 feet of the ground, and to generally function as follows: The hand-held receiver would display a numeric value, both on digital and log-scale meter that would change as a function of distance from the sending unit, decreasing numerically with a "reciprocal-of-the-distance-squared" relationship (as if measuring a free-field point radiation source) contour pattern of constant numeric value around the separated sending units. The sending unit(s) should have a high/low power setting and be effective to produce a detectable, reliable numeric value (within +/- 20 percent over all ranges) at a radial distance out of 800 meters. A circuit in the receiver should be capable of

discriminating low input signals to provide a threshold radiation field). Eventual intent is to incorporate the receiver electronics into present instrument cases to add realism. Size is a constraint, miniaturization is desired.

A87-77. TITLE: Tank Meteorological Sensor

DESCRIPTION: Current fire control algorithms for tank munitions requires input data on ambient pressure, temperature and relative humidity. These are now input to the fire control system by hand; thus, standard conditions are often selected to simplify set up. It is desired to take the gunner out of the process by developing a meteorological sensing system which will digitally input to the fire control computer. The system shall be required to sense atmospheric pressure and temperature, with relative humidity sensing desired. These properties shall be sensed external to the vehicle crew compartment in a manner that is not influenced by vehicle exhaust, incident radiation, and contamination by dust or gun emissions. The sensors shall be sufficiently robust to withstand vehicle motion and weapon firing, including both the main and secondary armament systems. The sensors will be designed for ease of calibration, fault diagnosis and replacement. The accuracy of the sensors shall be: pressure: +/- 0.02 in Hg from 17 to 33 in HG over the temperature range -65 F to +150 F; temperature: +/- 1 deg F; and relative humidity: +/- 3 percent. For initial test purposes, the output of the sensors will be in digital format with compatibility to civilian interfaces such as RS-232 and formats such as ASCII. Since it is desired to provide good quality within available resources, cost and performance tradeoffs should be identified.

A87-78. TITLE: Transitional Armature for Railguns

DESCRIPTION: The launch of a projectile from Electromagnetic Railgun requires that megampere range currents be coupled from rails to projectile by a pair of sliding contacts. Both solid and ionized gas (plasma) contacts have been employed. Solid, sliding contacts work effectively at low velocities providing conduction without head damage to the rails. Barring application of extremely high pressure, these solid contacts become ineffectual above velocities on the order of 1500 m/s. For these higher velocity conditions, contacts massive enough to remain solid under the resultant frictional and electrical heating would, thus, accrue and waste kinetic energy comparable to that of the projectile. Plasma contacts are effective at high velocities and require far less mass, but being less efficient conductors, produce great heat damage in the rails at low velocities. A "transitional contact" would provide low-velocity efficiency as a solid contact but would be sized for consumption and conversion (in part) to a plasma contact. Our requirement is for a proven predictive model for the transition. Choice of variables in the model should be such that conclusive tests can be conducted. The response to this request may be so written as to include these tests or to provide information for the sponsor to test premises and final results.

A87-79. TITLE: Insensitive Explosives

DESCRIPTION: Current Army explosives are more sensitive than is desired. In particular, munitions loaded with these explosives often sympathetically detonate in their storage configuration and react violently in a fire. Less sensitive explosives, which will make possible less vulnerable munitions, are desired. In addition to sensitivity characteristics, cost, processibility, stability in storage and transport, and de-milability are always important considerations in development of explosive formulations.

Composite explosives, which are combinations of a fuel and oxidizer, show promise in meeting the conditions mentioned above. Emulsification of composite explosives is currently being investigated. This process yields smaller grain size and greater intimacy of ingredients as well as surrounding each explosive grain with a lubricating integument. All of these tend in the right direction and also tend toward greater resistance to degradation from humidity. The use of solvated explosives, in combination with emulsification, may also be desirable. Solvation may make it possible to incorporate a higher percent of energetic ingredients into an emulsified explosive without raising viscosity.

We seek to develop low vulnerability explosives as energetic as composition B, which will react mildly in a fire when loaded into munitions. Cost, processibility, and stability are factors which will also be considered. We will consider any proposals, but we are particularly receptive to proposals dealing with emulsified explosives.

A87-80. TITLE: Fire Resistant Explosives

DESCRIPTION: The Army has a need for explosives which do not burn at atmospheric conditions but which will detonate in response to intense shock loading. Such explosives may burn when exposed to a strong heat source, such as a flame or embedded hot fragment, but they should not sustain burning when the source is removed. Some degradation of energy is permissible to achieve this objective. We would consider materials with a Gurney energy as low as 1.5 MJ/Kg, but more energetic materials are desirable. Ideally, the materials should be capable of being processed by casting or extrusion, but pressed materials might also be acceptable. Ideally, the materials should have some small strength, perhaps a yield strength of 100 psi, but pastes and powders would also be considered. The contractor should perform his own screening tests, and the proposal should explain how this will be done. For final evaluations, two kilograms of materials should be delivered for evaluation.

A87-81. TITLE: Strand Burner for Spectroscopic and Photochemical Probing of Burning Propellants

DESCRIPTION: Current studies of solid propellant combustion require advanced laser diagnostics. There exists a need for a strand burner facility that can allow for infrared (10.6 microns) and ultraviolet (ca.

200nm) access for laser induced fluorescence and absorption studies. Also, appropriate photomechanical means should be included to maintain the burning propellant strand in a fixed vertical position for sufficient signal averaging. The strand burner should be rated for operation up to 2,000 psi.

A87-82. TITLE: High Temperature Gaseous Flow Furnace for Laser Photochemical Studies

DESCRIPTION: Currently, there exists a need to experimentally determine the primary products of laser photolysis where the sample is at a high temperature and high pressure. Primary detection means for photochemical product detection are emission (e.g., laser induced fluorescence), laser absorption, and mass spectroscopic sampling. The facility needs include a sample chamber in which appropriate chemical (gaseous) samples can be flowed slowly or be kept in a static fill. This chamber has to be windowed to allow ultraviolet (ca. 200nm) photolysis, as well as that by a CO_2 laser (10.6 microns). Also, it has to possess sufficient heating means to assure a thermally equilibrated sample at a high temperature. Furthermore, it should have appropriate sampling means for mass spectrometric sampling. Minimum requirements include high temperature operations to 500 degrees Celsius and pressures up to 20 atmospheres.

A87-83. TITLE: Very High Burning Rate (VHBR) Combustion and Formulations Research

DESCRIPTION: Advanced burning rate promoters such as "hivelites" offer increased probability for fielding advanced ballistic concepts.

Both hydride (B10 and B12) salts, in particular, have shown great effectiveness as burning rate promoters in propellant formulations. Current use of these materials is based on empirical relationships and their mechanism of action is not understood. There exists a need for gaining further understanding of the details of VHBR propellant combustion and ingredient functioning.

The research involves combustion diagnostics and formulations work to examine in detail, variations in burning rate and safety binder, plasticizer and oxidizer species. In addition, the effects of catalysts in promoting the efficacy of boron hydride burning rate additives should be explored. Chemical decomposition and combustion studies of ingredient combustions and propellant samples should be conducted to help unravel the chemical details of the mode of action of the B10 an B12 salts. Finally, quantitative evaluation of the relative importance of physical factors such as density/porosity, particle size and sample mechanical properties relative to chemical effects should be made.

A87-84. TITLE: Titanium Alloy Fins

DESCRIPTION: There is a need to produce high strength-to-weight fin

sections that can withstand the severe inbore launch cycle and high aerodynamic heating experienced in flight phase. Titanium alloys appear to have the properties if economical manufacturing procedures can be developed. Typically the interior launch cycle may have peak temperatures near 2200 C for periods up to 20 milliseconds. Equivalent stagnation temperatures would be expected from aerodynamic heating for up to 5 seconds. The finished fin must be of a design to provide an aeroballistic efficiency equal to or better than those presently in use.

A87-85. TITLE: Protective Coatings

DESCRIPTION: There is a need for thin, light weight coatings that can be applied to aluminum alloy fins that can provide protection against the high temperature, abrasive environment of the interior launch cycle of tank guns and high stagnation temperature due to aerodynamic heating experienced during flight. The typical interior launch cycle may have temperatures near 2200 degrees celsius for time periods up to 20 milliseconds. Temperatures due to aerodynamic heating may approach that of the interior cycle for a period of 5 seconds. Protective coatings should not greatly affect the overall ballistic characteristics of the projectile; that is, the basic design drag, spin stability parameters.

A87-86. TITLE: Improved Manufacturing Methods for Producing Steel Fins

DESCRIPTION: The present methods of manufacturing fins for kinetic energy (KE) ammunition requires full machining of all surfaces of the fin units in order to insure straightness and tolerance requirements. An alternative method of manufacture using injection molded power steel alloys shows promise in producing high quality parts with reproducible tolerances equivalent to machined parts. The use of steel alloys as opposed to aluminum alloy stock will provide higher strength parts capable of withstanding much higher temperatures. Molding also will allow much thinner sections of more complex design, thus improving the aerodynamic efficiency. The requirement is to develop techniques and procedures that can produce high strength parts with tolerances and straightness equal to machined parts that survive the hostile environment and can be produced at competitive prices with existing methods of production.

A87-87. TITLE: Variable Pressure and High Temperature Closed Bomb Apparatus for Laser Ignition and Photochemistry Studies

DESCRIPTION: Ongoing laser ignition studies necessitate the construction of a closed bomb which will allow for both CO_2 laser (10.6 microns) and uv laser (193nm) ignition of a reactive gas mixture. This closed bomb should be heatable up to 200 degrees celsius and be able to withstand peak pressures up to 2,000 psi. It should also possess appropriate plumbing for rapid sample introduction and evacuation.

A87-88. TITLE: Helmet-mounted Stereo Display System

DESCRIPTION: Design/construct/characterize a helmet mounted display

system, capable of presenting a different view to each eye so as to produce stereoptic vision. The display would be an attachment to a helmet, and would be fitted with optics necessary to focus images properly within the eye, provide wide-angle viewing, and be used with minimal operator fatigue.

A87-89. TITLE: Flat Panel Display

DESCRIPTION: Devise and construct a flat panel TV-type monitor display, sufficiently rugged to withstand vehicular use, with viewing areas 9-10 inches diagonal measurement. Resolution should be 512 X 512 nominal. Thickness on the order of one to three inches is desired.

A87-90. TITLE: Tracking Laser Data Link

DESCRIPTION: Devise and prototype a laser data link that would consist of a stationary laser source/modulator/receiver and a passive retroreflective mobile modular that could be mounted on a vehicle. The source would track the mobile unit, keeping the reflector/modulator illuminated, would send modulated data to the mobile unit, and would receive modulated data from the mobile unit. The mobile unit would keep the reflector/modulator aimed at the laser source to send data. Data bandwidths of 200 MHz are desirable.

A87-91. TITLE: High Speed Non-polarizing Light Attenuator for Images

DESCRIPTION: Design and construct an electronically controllable neutral density filter that would provide attenuation of light levels prior to image intensification. The device would act as a front end to an image intensifier to both protect the image intensifier from damage by excessive light levels to allow for the use of night vision devices over a wider range of lighting conditions.

A87-92. TITLE: High Speed Electro-optic Image Shutter

DESCRIPTION: Design and construct a high speed shutter that would allow frame exposures of 0.1 milliseconds or less. An electro-optic approach is desirable. Such a system would be coupled to a high speed video camera unit to reduce motion induced blur in the acquired images.

A87-93. TITLE: High Light Level Image Intensifier

DESCRIPTION: Design and construct an image intensifier system that would provide light gains of 20 to 10000, with output light levels on the order of 3000 ergs/square-cm at 570 nm. Such an intensifier would be used on the front end of both electronic and photographic high speed cameras to provide adequate light for recording of high speed events.

A87-94. TITLE: Labnet Operating System and Host Workstations

DESCRIPTION: Design and construct a network of high performance work

stations that have the ability to launch processes to other stations in the net for parallel processing. The inter-processor communications system should be implemented in such a way so as not to slow system throughout, and the operation should be transparent to users.

A87-95. TITLE: Fiberoptic Redundant Communications Link Interface

DESCRIPTION: Design/construct an interface board that would accept digital data in the form of 32-bit words and would transmit/receive data over fiberoptic links at an 8 MHz word rate. The board would support 8 or more redundant links, could be instructed as to which link to use for a particular message, and would be transparent to data passing through any link not being used by the board.

A87-96. TITLE: High Frame Rate Video Sensor

DESCRIPTION: Design/fabricate/characterize a video solid state area sensor with resolution of 512 X 512 pixels (nominal) capable of providing frame rates of 1000 frames/second or greater, with intrascene dynamic range of 500:1 or more. Such a sensor would be incorporated into a camera and would replace many high speed film camera applications.

A87-97. TITLE: High Speed Data Acquisition System with Direct Disk

DESCRIPTION: Design/construct an 8 or more channel data acquisition system with an 8 megabyte/second data rate per channel, capable of writing the data continuously to disk systems at this rate. Such a system should be modular and expandable to more channels. Such a system would be used for image data acquisition, and other high bandwidth applications.

A87-98. TITLE: Embedded Help for Military User-Computer Interface (UCI) Design

DESCRIPTION: Work should focus on evolving techniques for aiding operators of computer systems while they are actually operating the equipment. The goal is to recommend standard ways of embedding training/operator aids in the system itself rather than relying on external prompts such as user manuals and cue cards.

Emphasis should be on innovative application of emerging technology such as icons and similar graphic tools. Use of task simulation games and other more complex training aids is not desired - work should concentrate on methodologies which will permit easy updating of information and help techniques as the systems evolve.

Proposals should demonstrate an understanding of the primary problems of the tactical computer environment - unsophisticated users, high turnover of personnel, limited educational background - and how these would be addressed through the suggested research.

A87-99. TITLE: Helmet Mounted Display Eye Sensor

DESCRIPTION: An coulomotor type device is required for use in laboratory based aviation and air defense human factors research which has the capability of being integrally mounted in a helmet system similar to the Virtual Visual Environment Display system (VIVED) developed by NASA's Aerospace Human Factors Research Division (reference: Electronic Engineering Times January 13, 1986).

It is desired that the device provide two capabilities:

1. Provide an output signal which is a measurement of pupil dilation as a response to workload stress which will be correlated with other workload/stress measurement techniques.

2. Provide an output signal which is the x/y coordinate of the helmet display upon which a subject is attempting to focus the eyes.

A87-100. TITLE: Human Factors and Artificial Intelligence for Logistics Planning Systems

DESCRIPTION: There is a need for the integration of advanced research techniques for the application of artificial intelligence (AI) to tactical logistics planning and scheduling problems. AI based decision support systems will be required to enable field logisticians to make maximum effective use of available supplies, storage and transportation assets for combat service support. AI based decision support systems will enhance the prediction of resupply requirements, the allocation of transportation assets, the rapid evaluation of alternative logistics support plans, and the determination of stockage, repair and distribution policies. Specific requirements are for:

a. an active, adaptive user interface to the knowledge based system which can recognize and model the goals, plans and preferences of individual users. The interface will recognize and resolve user-system misunderstandings, correct ambiguous queries, and provide compact, understandable explanations beyond the listing of rules fired.

b. a blackboard architecture for knowledge representation and effective communications between expert systems with specific domain applications such as inventory management, transportation, resupply requirements, weather, etc.

c. interaction with standard operations research techniques such as simulations, graph search methods, statistical analysis, etc.

d. analysis and expression of complex goals and constraints which have major bearings on the feasibility of logistics plans.

A87-101. TITLE: Human Factors Engineering Implications of Supervisory Control for Manipulative Robotic Systems

DESCRIPTION: A wide variety of Army applications have been proposed for systems which possess some measure of robotic performance. The robotic capability may be a mobility function or be associated with the specific mission the system performs or both. Many of the missions envisioned for military robotic systems required manipulative capabilities e.g., ammunition handling, explosive ordnance disposal, vehicle refueling, and decontamination. As system control evolves from teleoperation to autonomy, the human's role transitions from operator to supervisor (manager). This transitional zone offers many near term opportunities for force multiplication thru extension of system capabilities, proliferation of unmanned vehicle systems controlled by a single operator, and the potential for reduced operator training requirements and workloads thru reliance on automated functions.

Supervisory controlled systems impose new, frequently unprecedented demands on the human supervisor and the displays/controls with which he interacts. The principal focus of this SBIR activity is the expansion of the empirical database regarding supervisory control regimes for manipulative functions of Army interest. The SBIR activity will enhance an existing research activity, the Soldier Robot Interface Project, thru which a mobile manipulator equipped robotics/human factors testbed is being developed by the Human Engineering Laboratory. An important aspect of the interaction with the Soldier Robot Interface Project is the requirement for systems to demonstrate proof of principal for function in the field environment in which volume, power and weight constraints have a critical impact on the operational utility of the system.

Specific areas of interest within this SBIR topic include:

a. A machine world model consistent with human cognition, task, and machine capabilities. World model is to reduce operator workload by enabling high-level communication between operator and machine. World model may require vision or other sensors, and should enable (or may require) interaction with operator by means of designator, voice input, etc.

b. Operator perception of the machine, or "tele-presence". The operator requires remote viewing with depth perception (stereo vision, orthogonal views), and presentation of encoded sensor information (kinesthetic sense, tactile sense, force/torque, etc.) Presentation of machine world model is also desirable.

c. Operator control of the machine. The operator must control manipulator(s), cameras, designator(s), displays, and vehicle, perhaps concurrently. Interaction with machine world model is also desirable.

A87-102. TITLE: Nondestructive Evaluation Techniques

DESCRIPTION: Innovative Approaches are necessary to improve nondestructive evaluation (NDE) techniques for applications to structural materials of interest to the Army. Areas being considered for study are:

a. Develop a NDE technique for the quantitative determination of corrosion, with novel material discrimination and detection capability. Typical accomplishments for proving feasibility are the separation of aluminum alloys in detection/image processing, the measurement of the ratio of aluminum oxide (hydroxide) to aluminum, and the quantitative determination of water content and its location in aluminum-containing and other Army component samples. Detection of corrosion in critical areas of these samples, such as in delaminations, should be emphasized.

b. Develop a NDE technique to determine fiber volume fractions at any given point within composite materials.

c. Develop a NDE technique to extract information about the quality of individual bonds and layers within thin laminar composite materials.

d. Develop a NDE technique for prediction of the strength and integrity of adhesive joints between metals, between metals and composites, and between composites of the same or different matrices.

A87-103. TITLE: Protection for Fiberglass Reinforced Plastics

DESCRIPTION: Special characteristics are needed for fiberglass-woven roving laminated structures made with unsaturated polyester resins in combat vehicle applications. These are (1) non-absorption of chemical agents (simulants) and resistance to DS-2 and super-tropical bleach decontaminating agents, (2) retardation of its combustion when in contact with burning diesel fuel or ammunition and not continue to burn when the fire source is exhausted or removed, and (3) resistance to scraping and abrasion. Protection may be provided by (1) external well-bonded layers that might be molded-in when the laminate is made or can be applied later, (2) one or more ingredients added to the resin before laminating, or (3) by combinations of (1) and (2). Any increase in weight should be limited to 1 pound per square foot and preferably 1/2 pound per square foot. Strength and other properties of the laminate should be not more than minimally affected adversely.

A87-104. TITLE: Repair of Thick Fiberglass Reinforced Plastic Structures

DESCRIPTION: Novel procedures are needed for the repair of ballistic battle-damaged, reinforced-plastic armor structures that are simple, rapid and capable of being performed throughout a wide range of ambient conditions. Temporary repairs will be performed by crew personnel using hand tools with ambient conditions ranging from air temperatures of -40 degrees F to 120 degrees F, and in fair weather and in rain. Whatever is

added to make the temporary repair should be easily removable to permit permanent repairs. Permanent repairs will be done by rear echelon personnel in sheltered situations and having access to power tools. Battle damage may be only single impacts or multiple impacts closely spaced (3 to 12 inches apart on center). The damage may be holes partially or completely through the armor with surrounding local delamination and laminate deformation. Several temporary repair procedures are needed for achieving the following objectives: (1) sealing the hole or crater to exclude dirt, rain, and snow from the damaged area and to prevent air flow through it. In the case of a through hole, access is available only from the inside; (2) in addition to achieving the objectives of (1) above, restore the strength (stiffness/ballistic performance) to at least 75% of the original property. Access is available from both sides. Permanent repairs should restore these properties to the 90 percent level.

A87-105. TITLE: Surface Plasma Fluorination of Rubbers to Enhance Chemical Resistance

DESCRIPTION: Many flexible and resilient rubbers suitable for belts, hoses, and gaskets are not resistant to the deleterious effects of chemical warfare agents and decontaminants. Techniques must be developed to confer chemical resistance to the surface, while retaining the desirable bulk properties of the rubber. Conventional fluorination treatments of polymeric materials have not produced useful improvements in the barrier properties. Recent methods have been developed for the fluorination of polymer surfaces by means of a plasma generated from fluorocarbon gases. Utilization of the recently developed surface plasma fluorination treatments of rubber materials is desired to reduce or eliminate the sorption of (and degradation by) chemical agents and decontaminants.

A87-106. TITLE: Cure Monitoring of Composites

DESCRIPTION: Real time nondestructive methods are required for in-process cure and determination of residual stresses in fiber-reinforced organic matrix composites. Techniques should be capable of operating at cure temperatures up to 350 degrees F in a harsh processing environment such as an autoclave, press cure, or resin transfer molding; and be able to measure stresses induced in a composite structure during cure or as a result of environmental exposure or service conditions.

A87-107. TITLE: Nondestructive Evaluation of Thick Fiber-Reinforced Composites

DESCRIPTION: Novel nondestructive methods are required for real time (or near real time) inspection of thick (up to 2 to 3 inches) fiberglass or aramid fiber-reinforced organic matrix composites. Methods must be capable of determining the quality including delaminations, porosity, and density variations of large composite structures (10 x 4 feet) that have sweeping or complex curvatures.

A87-108. TITLE: Processing of Organic Matrix Composites

DESCRIPTION: Novel approaches are being sought in the processing of organic matrix composite materials to include:

a. Development of a computerized model which will predict the flow of liquid resin through thick (1" - 2" thick) laminates in the resin transfer molding process. The model would subsequently be used to drive a control system for the resin transfer molding process.

b. Methods for producing sandwich structures using continuous fiber-reinforced thermoplastic matrix skins. Techniques for establishing bond strength criteria in a continuous fiber-reinforced thermoplastic matrix sandwich structure. The core of the sandwich structure is preferred to be honeycomb. Novel approaches using structural foam core will be considered.

c. Methods for readily impregnating continuous high strength fibers with thermoplastic resins for use in subsequent fabrication of advanced composite structures via processes such as pultrusion or filament winding.

A87-109. TITLE: Innovative Machining Techniques

DESCRIPTION: The development of innovative material removal techniques as well as cutting tool materials and geometries for the machining of ceramic and metal matrix composite work pieces is desired.

A87-110. TITLE: Low-Cost, High Performance, Ceramic Materials

DESCRIPTION: High performance ceramic armor materials are expensive and because of this their applications are limited. To date, low cost ceramic armor materials have exhibited low performance. To meet current Army requirements, ceramic armor must be more widely used. Innovative materials processing techniques are sought to produce low cost high performance ceramic armor materials.

A87-111. TITLE: Ceramic Materials for Low Heat Rejection Diesel Engines

DESCRIPTION: Advanced diesel engines with minimal or no forced cooling are desired for Army applications. Key to obtaining such engines are structurally sound ceramics and ceramic coatings capable of maintaining mechanical and physical properties and dimensional stability with time in an engine environment. Innovative materials and processing techniques sought.

A87-112. TITLE: Improved Optical/Electro-Optical Materials Processing Methods

DESCRIPTION: Innovative technology is required to increase performance, availability and reduce costs of optical/electro-optical materials for Army systems. Areas of importance include:

a. Hard Optical Coatings: Broadband sensors require hard, erosion-resistant coatings which are transparent from ultraviolet, through the visible, well into the infrared radiation wavelengths. New concepts for such coatings compatible with state-of-the-art optical materials are desired. Such concepts should also address the practicality of operating reliably and being reproducible in production mode.

b. Single Crystal Growth: Many applications for single crystal optics are limited by size, perfection and cost of currently available single crystals. New or innovative methods of crystal growth aimed at addressing the above issues for materials such as Lithium Niobate, Stiontium Barium Niobate, Gallium Arsenide, Indium Phosphide, or Magnesium doped Lithium Niobate are desired.

A87-113. TITLE: Shock Absorber Filler Materials

DESCRIPTION: Metal ceramic composites are currently used for armor applications. A filler material is used between materials in a metal/ ceramic/metal composite. The choice of filler is based on its ability to minimize the shattering of the ceramic when impacted ballistically. Innovative filler materials are sought to improve structural integrity.

A87-114. TITLE: Effect of Weld Discontinuities on the Mechanical Properties of Armor

DESCRIPTION: In order to develop standards for acceptable weld discontinuities in Army vehicles, experimental data is required on the effects of discontinuities on armor. Welding discontinuities of interest include cracks, undercut, underfill, porosity and incomplete penetration. Examples of mechanical properties are ballistics, fracture toughness, fatigue strength, or impact properties. Armor materials to be considered should be MIL-A-46100 high-hard steel, MIL-A-46027 (5083-H131) aluminum, MIL-A-46063 (7039-T64) aluminum, or 2519-T87 aluminum.

A87-115. TITLE: Fluid Flow Past Complex Configurations

DESCRIPTION: Much progress has been made in the last decade in generating numerical procedures for solutions of both integral and differential equation formulations for fluid flow past complex configurations. Such subject areas as turbulence model formulations, unsteady flow, viscous phenomena, heat transfer and interacting or interference flows together with accompanying mesh generation and computer architecture coupling have been considered for a variety of applications. The time seems to be appropriate to encourage innovative research and development approaches for integrating some of these advanced methodologies into practical analysis tools for various types of relevant configurations. Accordingly, the Army Research Office seeks small business sources for development of innovative research and development efforts for generating ad hoc analysis tools for strongly 3-D flows such as in skewed rotating channels, rotor tips, blade-fuselage juncture, angle-of-attack bodies, etc. Of special interest

are the situations of aerodynamically loaded bodies periodically moving past attached structures, such as occur in small turbomachinery components or helicopter blade fuselage configurations. Complex and practical 3-D geometries should be the focus of such work. Augmentation of these tasks by various experimental studies for verification of concepts and the generation and/or use of benchmark experimental results for calibration of generated software might also be considered.

A87-116. TITLE: Optical Control of Microwave/Millimeter Wave Devices

DESCRIPTION: Microwave systems such as radar and communication systems which require phased array structures have increased in complexity and accuracy. Improved control and faster switching speeds have become inevitable for steering beams in phased array radars. Steering these beams are conventionally done by shifting the phase of individual amplifiers/ antenna modules using microwave control devices. These devices are controlled electrically. Improvements can be made in the control of these devices by the use of optical control. Some advantages of optically controlling microwave devices are short response times, high signal isolation, system flexibility, immunity to electromagnetic interference, low cost of fiber, and lightweight.

The principal goals of this program will be to (1) investigate an integrated optical/microwave GaAs FET and/or PIN device to control the phase of a microwave signal (2) investigate the feasibility of an optical/ microwave monolithic phase shifter for use in high volume phased array systems and (3) investigate fabrication techniques for this type of configuration that are compatible with proven microwave monolithic fabrication techniques.

A87-117. TITLE: Digital Spectroscopy of Piezoelectric Crystalline Media

DESCRIPTION: Apply the methods of digital spectroscopy to the precision determination of the effective permitivity and attenuation tensors of single crystal and composite structures comprised of piezoelectric crystalline media at microwave, millimeter wave and optical frequencies as functions of temperature and orientation. These basic material properties are required to be known to greater precision in order to more accurately design acoustic wave devices at higher frequencies and take full advantage of advances in circuitry. The objective is to achieve improved low noise oscillator designs for air defense radar receiver application.

A87-118. TITLE: Components for Rechargeable Ambient Temperature High Energy Lithium Batteries

DESCRIPTION: The Army requires a high energy (lithium) battery chemistry which can be used in either rechargeable or throwaway mode for training or combat applications, respectively. For such applications, a cell must utilize low-cost materials, must possess a theoretical energy density well above 300 watts/lb., must have the capability for providing internal

current densities up to 5 mA/cm^2 and must be capable of operating over the full military temperature range. These goals will be furthered through the development of new cell components including:

a. Low cost, high energy, positive plate materials and positive plates.

b. New chemically and electrochemically stable low cost, high conductivity electrolytes compatible with high energy electrodes.

c. Coatings and additives for improving the storage and rechargeability of the negative plate.

d. New microporous battery separators which will resist lithium dendrite penetration and possess resistance to highly corrosive electrolytes such as SO_2-$LiAlCl_4$ and ether solutions containing halogens.

A87-119. TITLE: Millimeter-Wave Semiconductor Wafer Probing

DESCRIPTION: With affordability becoming an increasingly important issue, MMIC's will find increasing application in Army systems. MMIC's will have significant cost impact on a wide variety of systems, including smart munitions, wideband EW warning receivers and phase array radars and jammers.

A major cost factor in the manufacturing of MMIC's is the test and screening of the individual circuit dies. This problem becomes even more acute as more functions are integrated on a single chip (i.e., T/R Module) and as frequency of operation is extended into the MMW region. Automated RF wafer level probe stations are commercially available today and most producers of MMIC's use some form of automated RF testing. The available equipment allows for automated wafer level calibration and corrected vector measurements to about 18 GHz. The RF probes employ co-planner waveguide structures in order to transition from the test equipment to the GaAs wafer. At frequencies beyond 18 GHz cross coupling between the signal and ground lines increases along with insertion loss and measurement accuracy is significantly degraded. This project will develop probe structures which will permit accurate automated RF wafer level measurements at MMW frequencies up to 40 GHz. This capability will allow for testing of MMIC's prior to being diced and mounted in a test fixture, resulting in a significant cost savings for MMW smart munitions and sensors, EW phase array jammers and phased array radars and ELINT warning receivers. This program will directly address the Army goals of affordability, producibility, low cost and packaging density.

A87-120. TITLE: Surface Acoustic Wave (SAW) Band Elimination Filter

DESCRIPTION: Perform a study which addresses the technology necessary to use high SAW resonators to perform a frequency band notch or band elimination function. The study will then be applied to model/breadboard devices verifying concepts. The filters shall be monolythic, applicable to

the UHF range and address the following target specifications; notch width of less than 0.01% with the lowest skirt ratio possible, notch depth of greater than 50 dB and attenuation of less than 2 dB in the pass band. Temperature stability is an essential parameter for very narrow notch filters and must be considered in the selection of substrate material. Low power dissapation, compact temperature compensation schemes may be considered.

A87-121. TITLE: <u>Crystal Plate Angle Correction for Precision Quartz Resonators</u>

DESCRIPTION: The frequency versus temperature characteristics of crystal resonators depend primarily on the angles of cut of the crystal plate. State-of-the-art cutting techniques cannot provide the angles of cut accuracies required for the high yield fabrication of precision resonators. Cost effective methods of correcting and maintaining the angles of cut subsequent to cutting need to be developed. Of special interest are SC-cut resonators, for SC-cut resonators are expected to be the principal cut used in future C^3, navigation, radar and IFF systems. Angles of cut accuracies of a few seconds of arc are required in some critically important applications.

A87-122. TITLE: <u>Epitaxial Gallium Arsenide Layer Growth on Silicon Substrates</u>

DESCRIPTION: Large, high quality gallium arsenide substrates for discrete microwave, millimeter wave devices, the proposed millimeter wave integrated circuits (MMIC) and high speed digital signal processing applications which have good mechanical strength and thermal properties are needed for DOD systems. The present bulk wafers (GaAs) are limited to three inch diameter and their mechanical and electrical properties are not sufficiently uniform for projected high quality production needs of DOD.

A87-123. TITLE: <u>High Efficiency Monolithic Gunn Oscillators</u>

DESCRIPTION: GaAs Gunn diodes have uses in many microwave/millimeter wave systems. Missile seekers, low power radars, EW jammers, and communications links all utilize Gunn diodes as oscillators for power generation. Presently, the microwave/millimeter wave performance of these devices is below potential. Next generation Army systems will need to incorporate a Gunn diode and its matching circuit onto a single substrate.

This monolithic approach has the following goals:

a. To lower the per-unit device cost by eliminating discrete device labor intensive fabrication procedures.

b. Improvement of reliability, uniformity, and reproducibility by overcoming fabrication difficulties associated with discrete devices.

c. Reduction of size and weight achieved by incorporating the matching circuit and the device on the same substrate.

d. Better performance due to the reduction of device to circuit transition parasitics.

A87-124. TITLE: Models for Multi-Region SAW Waveguides on Anisotropic Substrates

DESCRIPTION: To develop an analytical model which describes the behavior of surface acoustic waves (SAW) traveling within a SAW transducer whereby the transducer structure is viewed as an acoustic waveguide consisting of three distinct regions: metal (i.e. bus bars); semi-metal (i.e. electrode region) and free surface. The program would have the following goals:

a. Develop the SAW waveguide modeling techniques necessary to analyze the complex transducer structure that results in achieving the desire modes of propagation that in turn significantly improve SAW device performance.

b. Develop methods for modeling the effects of SAW substrate anisotrophy in the waveguide model.

The results of this effort would provide the basis for developing a wide range of high performance SAW devices including bandpass filters with 75-80 dB of out-of-band rejection; low-loss bandpass filters with 2-4 dB insertion loss and pulse compression filters with 40-50 dB time sidelobe suppression.

A87-125. TITLE: Millimeter Wave InP Device Structures

DESCRIPTION: Millimeter wave missile/submunition sensors require high efficiency/power and low noise Gunn devices at frequencies to 300 GHz. InP and its related materials are superior to GaAs in both efficiency and output power. Theoretical efficiency of an optimized InP Gunn oscillator with uniform E-yield is 45%. However, at present this figure is limited to 7-9% using VPE grown current-limiting cathode device structures. This program is to address optimized profile Gunn devices in InP, GaInAs, and GaInAsP by use of MOCVD technology wherein doping layer control is typically 20A. Various profile Gunn devices structures are to be grown, processed, packaged, and evaluated for performance at 100 GHz. Device design is to be optimized using graded-drift region, Schottky barrier, ohmic contact and current limiting cathodes. Discrete and planar/ monolithic device structures are to be addressed.

A87-126. TITLE: Ultrahigh-Speed GaAs/AlGaAs Heterostructure Devices

DESCRIPTION: Future military requirements for real-time information acquisition and processing in tactical EW, DC3I, and smart munitions establish a need for ultralarge-scale and superhigh-speed integrated circuit microelectronics. New classes of solid state devices such as

quantum-well supermatrix structures and selectively doped heterostructure transistors, promise the possibility of ultrahigh-speed (picosecond) switching and high frequency (10-100 GHz) mm-wave components for microwave/microelectronic integration. These devices exploit the concept of one-, two-, and three-dimensional electron confinement through the use of molecular beam epitaxy (MBE) and ultrafine lithographic techniques. Application of patterning methods such as e-beam direct write with plasma etching (RIE, RIBE, ion milling) is required for fabrication of these device structures having feature sizes from 100A to 1000A. Damage effects, noise figures, and high frequency response and logic delay times are to be studied through electrical characterization.

A87-127. TITLE: Heterostructure Launched Gunn Oscillators

DESCRIPTION: Next generation smart missile and munition systems will require high efficiency/power and low noise solid-state millimeter wave oscillators at frequencies to 100 GHz. In particular, these devices should be designable for monolithic integration for low cost and weight considerations. Present solid-state materials' selection for monolithic integration is limited to III-V compound semiconductors, in particular, GaAs and AlGaAs. Current GaAs Gunn device structures are characterized by low output power, frequency of operation, and efficiency which, in turn severely limits present system performance. An approach which shows promise in advancing the state-of-the-art in millimeter wave oscillators is the GaAs/AlGaAs heterostructure launched Gunn structure which offers a new technology input for the increased control of efficiency and output power. This program will address the basic fundamental design considerations of this device structure, identify the various modes of operation, designs for launching of a Gunn dipole or accumulation layer, placement and composition of the launching region, relevant output power and efficiency, and planar versus discrete device construction.

A87-128. TITLE: Heterojunction Double Barriers for Logic Circuits

DESCRIPTION: Heterojunction double barriers which have a negative resistance region are potentially a high speed logic storage device. Such a device would be driven by the high impedance of a transistor collector. Calculations of the characteristics of such a device in a real circuit configuration are needed. Calculations must include the effects of interconnections on the wafer. Desired characteristics include switching speed, power, voltage levels, and fan-out given as a function of device geometry.

A87-129. TITLE: Radiation Hardened Crystal Oscillators for Clocks and Frequency Standards

DESCRIPTION: Evolving C , navigation, radar and IFF systems require ever tighter tolerances on frequency standards and clocks. As the tolerances become tighter, the radiation-induced frequency shifts become an increasing portion of the tolerances. For some systems currently under development,

the radiation-induced frequency shifts are a major limitation on the achievable system performance. Novel methods of reducing the frequency shifts due to low and high levels of ionizing radiation (gamma rays, X-rays, neutrons) need to be developed.

A87-130. TITLE: Comprehensive Computer Models for GaAs IMPATTS

DESCRIPTION: GaAs IMPATT Devices generate more power, both pulsed and CW, with higher efficiency, than any other microwave/millimeter wave solid state device. Improved accuracy of computer models is needed to improve and speed up design procedures. For millimeter wave operation this is particularly true because many physics of device limitations remain unknown.

The principal goal of the program will be as follows:

Utilizing DC, small signal analysis, large signal analysis and an accurate thermal model, develop software that will enable the user to calculate any of the vital characteristics of IMPATT diodes. The following stipulations apply:

a. The software must be flexible enough to allow the user to change any parameter in regard to device material, structure, size, doping, DC and RF operating characteristics, operating temperature, thermal resistance and other important considerations.

b. It should be kept in mind that the purpose of the software will be for two major uses, that of design and optimization of doping profiles and for the analysis of existing profiles.

c. The software should be able to analyze all types of structures including hybrid, single and double drift.

d. The software shall be able to plot the calculated E-field, hole current, and electron current vs active layer depth.

e. The software should be IBM PC compatible, and written in PASCAL.

f. Deliverables will be one or more 5-1/4 inch floppy disks with the software on it, and a commercially produced PASCAL compiler.

g. Complimentary sub-programs may be included.

A87-131. TITLE: Optically Isolated Sensors for Megawatt Components

DESCRIPTION: Efficient, reliable megawatt electronics for advanced tactical and strategic weaponry requires optical isolation of sensor signals feeding command/control logic. The power levels needed for future weapons such as electromagnetic launchers, microwave weapons, lasers, particle beams are so high that existing isolation techniques will not

protect the low voltage computer-controllers. The sensor signals include pulsed voltages across multi-kiloampere switches which vary in voltage from tens of kilovolts to a few volts in times less than 10 nanoseconds; currents that range from a few hundred amperes to megamperes in a millisecond or less; timing signals with 100 picosecond jitter. The goal is to devise passive optically isolated sensors that derive their operating power from the signal it is measuring, though tens of hours of battery powered operation would be acceptable. Approaches should include the use of electro-optic, faraday rotation, and similar techniques. Active techniques include the use of a laser diode probing signal transmitted to the device to be measured via fiber optics with the return signal converted to analog or digital voltages at the computer-controller.

A87-132. TITLE: Microwave/Millimeter Wave RF Interaction Circuits

DESCRIPTION: RF interaction circuits are required which provide the necessary interaction with electron beams for high efficiency, wide operating bandwidth and low cost manufacture. Emphasis is directed to innovative fabrication techniques such as developed for solid state IC's but using vacuum qualified materials such as BeO, BN, and copper.

A87-133. TITLE: High Current Density Electron Emitter for Vacuum Electronics

DESCRIPTION: New Microwave Power Generators, Oscillators and Amplifiers require electron emitters (cathodes) that will reliably provide high electron currents, 100-10,000 amperes (current densities of 100-1000 a/cm^2). Emission materials must be investigated and cathodes fabricated to demonstrate high current. A secondary effort requires life test under pulsing conditions to achieve long life in vacuum environment of 10^{-6} to 10^{-6} pascals.

A87-134. TITLE: Computational Techniques for RF Circuits and Electron Beams

DESCRIPTION: Modeling of vacuum electronics devices such as traveling wave tubes, crossed-field amplifiers and relativistic-interaction devices is critical to avoid false starts and expensive hardware fabrication. Computer simulation will avoid costly experimental development and provide a substantial theoretical baseline from which to develop improved classical tubes and discover mechanisms for advance tube designs.

A87-135. TITLE: Composite Applications for the Counterobstacle Vehicle (COV)

DESCRIPTION: Phase I - Study to investigate and recommend weight reduction through the use of composite or other lightweight structural materials on the mineplow, telescopic arms and other appropriate components. Change of materials shall not degrade current performance of subsystems. It is desirable to reduce major subsystem component weights by 50%.

Phase II - Design, Fabricate, Integrate and Test one telescopic arm on the COV using recommended material changes.

A87-136. TITLE: Quantification and Measurement of Visual Bireflectance Distribution for Decoys

DESCRIPTION: Phase I shall study the capability of the Bireflectance Distribution Function (BRDF) or an alternative approach to specify the needed visual replication parameters for decoys. Equipment needed and measurement procedures shall be identified and breadboarded for the best technical approach. The realism of a decoy is highly dependent upon the resemblance of color, reflectance, and texture to the object it is to simulate. Presently, the replication of most complex 3 dimensional objects having shadows and depth consists of painting a two dimensional fabric panel. A means is needed to define, measure, and establish tolerances for the replication. The Bireflectance Distribution Function is believed to be one potential solution. Presently available commercial glossmeters have not proven useable due to the low (usually <5%) reflectance of the real object. Phase II shall provide a prototype measurement system and demonstrate the technical feasibility of specifying visual parameters of decoys. Supporting test and evaluation shall be performed.

A87-137. TITLE: Foam Air Decoys

DESCRIPTION: Research of materials and concept development for determining feasibility of fabricating two and three dimensional decoy devices using flexible foam air inflatable beam molding techniques that store in small volume, low weight and provide rapid deployment. Phase I shall study and establish the concept of inflatable foam with hybrid support means to be technically feasible with small scale alternate material demonstrators for decoys. Phase II shall provide selected full scale, large volume, decoy material demonstrators with supporting test and evaluation to evaluate concepts.

A87-138. TITLE: Research in Materials with Dual Radar and Thermal Suppression Characteristics

DESCRIPTION: Research in materials and/or coatings that have both radar absorbing properties and low emissivities in the infrared wavelengths. Phase I theory and material feasibility explored. Phase II sample materials should be produced and submitted with test data verifying the thermal and radar characteristics. Thermal data should include low emissivity in infrared band, reflectance spectra from visible through infrared, and thermal imagery. Radar data should exhibit good attenuation by absorption and/or scattering in X band radar.

A87-139. TITLE: Advance Field Fortifications Protective Structure Systems for Weapons/Personnel Positions

DESCRIPTION: Development of an advanced lightweight and deployable structural system for protection of battle field weapons and personnel

positions. The goal is to enhance field fortification capabilities on the Modern Airland Battlefield to protect the individual soldier, his equipment and weaponry. (Tent-type above ground shelters, are not to be considered viable candidates for the purpose of this effort.) Effort will consist of two phases: (1) Study to identify viable candidates to include evaluation of their logistics burden and (2) prototype fabrication for demonstration and evaluation of the best technical approach.

A87-140. TITLE: Universal Cleaner for Reverse Osmosis Water Purification Unit Membranes

DESCRIPTION: Fouling of the RO membranes is a principal obstacle to the continuous, steady, and rated output of potable water from the field Army Mobile Water Purification Units (ROWPUs). The fouling can take many forms including organic slimes, microorganisms accumulation, and inorganic scale. Also, the degree and type of fouling is a function of the three different membranes currently being used. A universal cleaner is needed which will remove the fouling material quickly and effectively without damaging any of the different type membranes being used.

A87-141. TITLE: Hybrid Circuit Designs for Power Processing Applications

DESCRIPTION: It has been shown that multiple discrete transistors can be interconnected in parallel on a common heat sink and integrated with control logic and driver functions in a package to form a high capacity power switch. Hybrid circuit technology provides the capability to combine these functions on single substrates for higher reliability and lower weight and volume. The purpose of this effort is to investigate hybrid circuit designs combining logic and protection circuits with power devices for application in power processing.

A87-142. TITLE: Improved Chlorine Feeder for Reverse Osmosis Water Purification Units

DESCRIPTION: The disinfection step is a very important unit operation in the total Reverse Osmosis Water Purification Unit (ROWPU) treatment scheme. It is essential that the chlorine be delivered continuously and precisely. The present feeder does not operate satisfactorily on the high test calcium hypochlorite mandated for use. Insoluble calcium hydroxide and calcium carbonate cause clogging and other problems. A new feeding system is needed to handle $Ca\ (OCl^2)$.

A87-143. TITLE: High Energy Density Storage System

DESCRIPTION: Build and test a 1 kW prototype of a battery which could be rechargeable, have an energy density greater than 3 times a lead-acid battery, have a long storage life, have a short activation time and be low cost. The system should be scalable for the development of larger storage systems.

A87-144. TITLE: Automated Intelligent Power Distribution Modules

DESCRIPTION: Tactical military systems are heavily dependent on electric power. For efficiency and to reduce the logistics burden of supplying electric power in the field, user equipment is often interconnected with a distribution system to a central generator set. It is desirable to apply load management techniques to these distribution systems to allow load shedding, duty cycle scheduling and graceful degradation under adverse conditions. The objective of this effort is to investigate the development and application of "intelligent" load management and power distribution modules.

A87-145. TITLE: Weld Aging of 7005 Aluminum Alloy

DESCRIPTION: There is a need to field weld repair structural aluminum alloy 7005 and to speed-up the aging process of the alloy beyond the 21 days now required to reach its high yield properties. There have been reports of the use of subresident vibration of materials to effect stress relief and/or stress redistribution. Since part of the process of material aging is an establishing of a stable stress level, the treatment of new weld metal deposits to subresident vibration energy input may serve to speed up the aging process. An evaluation program to compare 7005 welded samples subjected to subresident vibration during and/or after welding to unexposed weld samples by tensile testing could be explored in a Phase I program. If results proved positive, then Phase II could be used to determine effects on the full range of mechanical properties for all 7000 series aluminum alloys.

A87-146. TITLE: Aluminum Welding Radiographs, Development of Standards

DESCRIPTION: There exist graded radiographic standards for steel welds (ASTM E390), however, there are no graded radiographic standards for welds of wrought aluminum only reference radiographics. The use of graded welding radiographs developed using steel material continues to generate contractual administrative problems when there is a need to quantify (grade) aluminum welds. Welded aluminum materials are being designed into increasing numbers of military items in order to take advantage of the lighter weight material. Graded aluminum radiographs for incomplete penetration, lack of fusion, tungsten inclusions, fine scattered porosity, cause scattered porosity, clustered porosity and linear porosity for various thickness ranges, for example 0.03", 0.08", 3/16", 3/8", and 3/4" are needed. The ascertaining of aluminum radiographic data bank along with their reference descriptive data for use by evaluations to formulate the base of a standard for aluminum welds could be developed in Phase I. A Phase II in which specific graded radiographic, standard welded blocks, and consensus standard are developed would be the goal.

A87-147. TITLE: Tactical Deception Infrared Signature/Generator Alternatives

DESCRIPTION: Phase I shall research alternative means of replicating

IR/thermal signatures in the form of a two (2) dimensional panel. It is intended that these panels be employed in decoys simulating combat vehicles. Selection of best alternative shall include RAM, safety, weight, volume, and overall feasibility considerations. Phase II shall research and develop a means to power the two (2) dimensional panel resulting from Phase I efforts. Selection of power source alternative shall be based on Phase I considerations with special emphasis placed on safety (currently, gasoline generators represent a safety hazard when field deployed).

A87-148. TITLE: Lightweight Low Emissivity Materials

DESCRIPTION: Research in lightweight materials which are flexible, drab color, heat resistant, and suppress thermal radiation. Phase I theory and material feasibility explored. Phase II sample materials produced and submitted with test data to support required characteristics. Data to include reflectance spectra from visible through infrared, thermal imagery, emissivity measurements.

A87-149. TITLE: Low Cost Dual-Polarized Microwave and Millimeter Antenna Designs

DESCRIPTION: Innovative designs for dual-polarized microwave and millimeter antennas that may be used in a monopulse configuration for seekers and sensors are needed. The design must feature the potential for low cost production and integration with monolithic microwave and millimeter integrated circuit technology to provide a low cost front end for sensor or seeker applications. The design may feature any number of basic antenna approaches, including arrays of elements, or primary feed and reflector with producibility a key element in the approach.

A87-150. TITLE: Highly Oxygenated/Low Hydrogen Content Plasticizers for Solid Propellants

DESCRIPTION: Minimum smoke solid rocket propellant requires larger amounts of oxygen in the combusting materials to achieve a minimum or no smoke production and eliminate afterburning. The problem has been that oxygen in the energetic groups such as nitro and nitrato in plasticizers such as nitrogloycerine, have increased oxygen at the expense of making the propellant sensitive to shock, friction and impact. What is needed are plasticizers which have significant amounts of oxygen, similar to nitroglycerine, but do not have the sensitivity of nitroglycerine. Also, low hydrogen content plasticizers offer potential advantages of signature reduction, increased energy, and improvement of propellant physical properties. Desired properties of the new plasticizers would be to have low vapor pressures, similar to the adipates, have low crystallization temperatures and be thermally stable to 74 degrees C and have a freezing point below about -30 degrees C.

The investigation should identify potential liquids which are highly oxygenated and/or relatively low in hydrogen content to be used as

plasticizers for solid propellants. In addition, effort should be directed towards obtaining from commercial sources a number of candidates which could then be compounded with other typical propellant ingredients to formulate one or more typical solid propellants. Finally, a synthesis effort to obtain any outstanding candidate(s) that had been turned up in the literature survey or in professional discussions would be initiated with the candidate(s) submitted to formulation in a propellant.

A87-151. TITLE: High Altitude Plume Modeling

DESCRIPTION: In a high altitude maneuvering interceptor vehicle, control jet and/or main propulsion system motor plumes can expand to very high angles. The exhaust jet material will create an obstruction to the rarefied high speed approach flow and produce very complex gas dynamic interactions. The exhaust gases may contaminate sensors and windows on the vehicle compromising the effectiveness of the vehicle. The low energy boundary layer of the exhaust jets is the primary source of potential contaminants. Innovative approaches to the solution of these high altitude, rarefied expansion and interaction regions are sought. New ideas for gas dynamic modeling techniques applicable to free molecular, transition, and continuum flow regimes are needed to produce a comprehensive solution to this complex problem.

A87-152. TITLE: Video Image Overlay

DESCRIPTION: A technique or device is needed which allows the simultaneous display of several synchronized or unsynchronized video images. These images should be displayed on single monitor with each image having an independent control for parameters such as brightness, contract, and total number of pixels occupied. It is important to display these images in real-time without processing delays. The display should be updated as television frame rates.

A87-153. TITLE: Compact Near-Millimeter Wave Sources

DESCRIPTION: There is a need for small, compact, and rugged sources that operate in the 0.7-2mm wavelength region. Such a source would probably be solid state. Presently, available sources are limited to either lasers that require bulky CO_2 laser pumps or backward wave oscillators that require large power supplies. Output power requirements are 100 microwatts required, 10 milliwatts desired.

A87-154. TITLE: Automatic On-Line High Strength Fiber Optic Splicing

DESCRIPTION: Manual optical fiber splicing techniques are presently employed to repair broken optical fiber links. These techniques are both time consuming and labor intensive. To date, no on-line repair methods exist for correcting fiber breakage associated with production-wound fiber optic bobbins or cable packs. Current techniques lack automated controls and quality inspection units that are required for automated on-line

splicing of optical fibers that are wound using an automated winding system. This project will analyze system requirements and develop a concept for a low cost, automated, on-line system capable of producing high strength fiber optic splices to repair fiber broken during winding. The concept resulting from this effort will provide for a "menu-driven" computer controlled system which will result in limited specialized operator training, manual intervention, and will substantially reduce the time and labor required to perform the task of splicing the optic fiber, thus allowing greater productivity by the user.

A87-155. TITLE: Environmental Effects on Optical Fibers Wound Under Tension

DESCRIPTION: Optical fibers designed for military applications must maintain high strength and uniform optical properties over long storage life (10 years). Use of optical fibers in guided missile applications possess special problems in environmental effects that are distinctly different from those in the commercial sector. The fiber must be wound, under tension, onto a tapered spool to be payed out at high speeds. Stress corrosion caused by water vapor can degrade the mechanical properties of the fiber under stress during long-term storage. Further, the adhesive used as a binder for cable pack stability, can cause defects in the fiber buffer coat when stored in various environments.

The objective is to provide research on the degradation of the mechanical and optical properties of fiber-optic bobbins under simulated environmental conditions. An integrated program to investigate the simulated environmental effects on optical fibers for guided missile applications is needed in order to understand the interrelationships between the variables including: bobbin design; tension profiles; adhesives; fiber types including both single mode and multimode, with and without hermetic coatings. An important part of the investigation is to also understand the differences in affects caused by an aluminum bobbin vs a composite bobbin.

A87-156. TITLE: Water Canteen Temperature Maintaining System for Combat Vehicle Crews

DESCRIPTION: Study and develop a concept for keeping the available portable water supply in a combat vehicle at such a temperature that will encourage the crew to drink it. At present, the plastic water container and the crews personal canteen are affected by the vehicle interior temperature which could rise 20 to 30 degrees above the ambient temperature in all buttoned up missions. Thus, it is very difficult to encourage the crew to drink sufficient water needed to keep up with their body electrolyte balance. Some type of technique is required, that would consume very little or no power, at least for water canteen temperature control.

A87-157. TITLE: Robotic Vehicle Mission Packages

DESCRIPTION: The capability for a combat vehicle to accomplish a mission

has been driven in the past by human control requirement. The concept of robot vehicles accomplishing missions performed originally by soldiers will result in more efficient, smaller and potentially more productive robot systems. The reduced volume, elimination of controls (pedals, handles, knobs, etc.), microprocessor management, reduction of crew interior volume, sensor improvements for machine and human remote control can now be realized in robotic combat vehicles. Robotic sensing systems might include, but not limited to, stereo thermal imaging, NBC contamination, mine detection, terrain typing, vehicle following, etc. Techniques described above can be applied to a number of robotic missions the Army will consider under the Armored Family of Vehicles program. Mission roles under consideration include tactical reconnaissance, NBC reconnaissance, mine detection, rearm, refuel, decoy, etc.

A87-158. TITLE: Robotic Vehicle Command and Control

DESCRIPTION: The Army is interested in the remote management of multiple robots from a single command center. The operation of the robot vehicle will be simultaneous with no degradation in system effectiveness. In order to control multiple robots simultaneously, new techniques in operator interface are required. The operators will manage up to a platoon of four or five robots from a single Robotic Command Center (RCC) located in a manned close combat vehicle operating in concert with the robots. The requirements for the RCC to operate on the move, also constrained by the small volume within the combat vehicle, require a new approach to controls and displays for the robot operator. Control of the robots, the remote displays or information being processed considered by the operators must be controlled through optimized operator interfaces. New techniques in interactive aids display technology, voice control, vehicle status indicators, decision aids for single and multiple robot control and other human interface augmentations are required before the full combat benefit can be realized for robotic combat vehicles.

Techniques described above would supplement ongoing joint ARMY/DARPA robotic vehicle programs. Simulation of the capability would be considered an essential first step in the implementation of the techniques in the ARMY/DARPA programs.

A87-159. TITLE: Development of Dust Detector for Combat/Tactical Vehicles

DESCRIPTION: Failure of air cleaner systems is a major cause of engine failure. TACOM is currently investigating various methods of detection and alarm when particles are entering the engine. Methods include acoustical, electrostatic, light scattering and laser defraction. It is not clear what approach is optimum or whether investigations to date have been comprehensive. Requirements exist for inexpensive sensor with simple warning to the operator and for more elaborate systems which provide data with prognostic potential. Examples of this data would be particle size distribution, concentration (grains/ft^3) and total ingested mass.

A87-160. TITLE: Vehicle Instrument Panels

DESCRIPTION: Vehicle instrument panels are an item that have never received a great deal of attention. Fabrication costs and maintenance and installation effort could be reduced. Panel configurations could be less restricted.

An instrument panel could be considered as an adapter between input connectors and gauges. Input connectors could be located at a convenient location. All gauges and switches could be face mounted. The panel could be solid, insulated block with internal wiring between input and output with connection for test instruments.

The project consists of the design and fabrication of an instrument panel for a tracked vehicle and one for a wheeled vehicle. Production costs would be calculated and the instrument would be laboratory and field tested.

A87-161. TITLE: Military Diesel Engines

DESCRIPTION: The general needs of military diesel engines include extended fuel tolerance, extended environmental tolerance, increased RAM-D, increased fuel economy, improved transient response, high power density and reduced specific heat rejection.

Some key technology areas which will allow advancement in the above area to be accomplished include: (1) high temperature engine materials and tribology systems, (2) fuel injection systems for better light load and idle fuel economy, (3) fuel and air systems for combustion control, (4) high efficiency, broad range turbo-machinery (providing APU functions if possible), (5) full authority engine control, (6) techniques for friction minimization, (7) cold start techniques, and (8) variable valving mechanisms.

Work efforts which address the above areas would be most relevant to the enhancement of military diesel engines.

A87-162. TITLE: Diesel Engine Reliability/Durability Algorithm/ Methodology

DESCRIPTION: In the process of the assessment/selection of an engine for a given military vehicle, the task which presents the greatest difficulty and yields the most uncertain results is the determination of reliability and durability. Basically, this is due to the large number of complex factors and inter-relationships involved. However, for military vehicle applications, the task is further complicated in that (1) the military rating of an engine is often considerably higher than the commercial rating and (2) the military environmental conditions are considerably more severe than encountered under commercial use.

As a means to upgrade the reliability/durability assessment, there is a need for the development of an algorithm/methodology that will (1) address all of the diverse parameters and processes involved, (2) accept the design and operational input criteria required, and (3) calculate a valid prediction of reliability and durability for an automotive diesel engine.

A87-163. TITLE: Computer Aided Design (CAD) for Producibility

DESCRIPTION: A need exists for the ability to assess producibility considerations during the design conception of a given component. Ideally, one would want inherent in a CAD system, the capability to optimize a part design from a manufacturability perspective during or following the design of the part. This could be a powerful tool both for part design and for evaluation of a given design for producibility review purposes.

A87-164. TITLE: VETRONICS Laboratory Equipment Requirements

DESCRIPTION: There is a need to determine what kind of laboratory/field equipment is desired for efficient integration of electrical/electronic systems in military ground combat vehicles.

Some of the military vehicle systems that would require VETRONICS application are as follows: fire control, stabilization, engine control, integrated defense, and target acquisition system.

A87-165. TITLE: Robotic Laboratory Equipment Requirements

DESCRIPTION: The objective of the robotic laboratory/field testing is to evaluate advanced techniques in remote operation on ground combat vehicles, digital terrain displays, computer-aided packages and demonstrate military potential of advanced robotic vehicles and technology.

To fulfill the Army requirements for robotic vehicles, there is a need to determine in advance what kind of laboratory and field equipment is required to conduct laboratory field testing in order to evaluate the robotic concepts and systems.

A87-166. TITLE: Portable Electrical Components

DESCRIPTION: The cost of electrical boxes in combat vehicles could be reduced, along with a reduction in maintenance costs and an increase in reliability if the electrical boxes are designed as modules. Material and assembly costs would be reduced. Modularization would reduce the size of the units and replace maintenance and repair operations by simple replacement.

Electrical boxes, such as a switch box or control box could be made of bare components encased in plastic or some other insulating material. Other boxes could be investigated for adaptability to similar fabrication techniques.

This project consists of fabricating electrical boxes, calculating their cost on a production basis, and testing those boxes in a combat vehicle.

A87-167. TITLE: Track Standing Wave Analysis

DESCRIPTION: At higher speeds, the momentum of the track on tracked vehicles forms standing waves. These standing waves absorb power and reduce drivetrain efficiency. The hysteresis of rubber bushings in single pin tracks or the hysteresis of the rubber surrounding the pins in double pin tracks dampens the standing waves to an acceptable level. However, the rubber material on tracks is a prime cause of failure and represents a large portion of the life cycle cost of the track. It would be possible to use a more rugged and less costly unbushed track if a means could be found to externally dampen the standing wave formation.

The project would consist of performing analyses on single pin bushed, single pin unbushed and double pin tracks. The analyses should consider using either front or rear sprocket drive with or without support rollers. The analyses should determine track motion, forces, and energy, and a critical damping factor should be derived in each case.

A87-168. TITLE: Vehicle Input Loads

DESCRIPTION: Vehicle input loads remain an educated guess. There are no agreed upon parameters to which suspension systems and frames of vehicles can be designed. Competing companies are thus each designing a vehicle to the same set of requirements, but using different parameters.

Existing literature and company standards should be compiled for suspension input loads as a function of vehicle type, terrain, and speed. Loads should be listed as multiples or the acceleration of gravity(g's). If a standard were derived from these tables, vehicles could be designed by different companies to the same set of boundary conditions.

A87-169. TITLE: Quick Disconnect Coolant Hose Clamp

DESCRIPTION: A major cause of engine failure in combat vehicles is loss of coolant, resulting in engine overheating. Cooling systems consist of a myriad of hoses connecting radiator(s), expansion tanks, engine and auxiliary coolers. Silicone or rubber hoses are connected to aluminum or steel fittings with heavy-duty automotive screw actuated band clamps. Connections may be "blind", causing incorrect installation, hoses deteriorate and harden, clamps fail, resulting in loss of the engine.

A quick disconnect hose clamp is envisioned that will have the following features:

a. Easy to use
b. Prevent long-term coolant leakage

c. Maintenance-free
d. Compatible with silicone hose

In addition, the quick disconnect hose clamp will not require tools during installation and removal.

A87-170. TITLE: Field Remanufacturing/Rebuild

DESCRIPTION: If failed parts could be remanufactured or rebuilt in the field, the burden on supply channels could be eased and vehicles could be returned to service sooner. In many cases parts or assemblies could be modified to take advantage of a remanufacturing capability.

The first part of the project would consist of tabulating failed parts by frequency of failure and also by the criticality of the failure to operation of the vehicle. Each failed part would then be analyzed to determine the feasibility of remanufacturing or rebuilding it under field conditions.

The second part of the project would consist of selecting or describing machines that would comprise a flexible machining system to perform the remanufacturing and rebuilding. The flexible machining system would have to be transportable on one or more tracked or wheeled vehicles.

A87-171. TITLE: Barrierless Air Cleaner (Non-Electrostatic)

DESCRIPTION: To develop a non-electrostatic barrierless air cleaner that has no moving parts and has a 99.5 dust removal efficiency on AC course and obtain a minimum 50-hour service life to 20 inches of water pressure drop. Today, air cleaners require frequent servicing in dusty conditions and pose a contamination risk factor to media material and maintenance personnel during cleaning in an NBC environment.

Exploratory development concepts will be evaluated to determine approach feasibility. Mathematical modeling and parameter generated studies will be formulated to provide performance predictions. Successful paper study will provide for continued breadboard evaluation of lab working model in Phase II.

A87-172. TITLE: Time Domain and Frequency Spectrum Analysis

DESCRIPTION: Develop software to conduct a menu driven Time Domain and Frequency Spectrum (TDFS) signal analysis on an IBM PC/Compatible computer (MSDOS 2.0). This software will be comprised of commercially available TDFS signal analysis software modified to incorporate a user friendly menu operating system to allow the operator easy access to all the TDFS signal analysis programs contained in the software. The software would be required to analyze Time Domain and Frequency Spectrum waveforms ranging from 0 to 1 sec and 5 msec data resolution and 0 to .2 MHZ with 20 HZ data resolution, respectively. In addition, the software would contain search

routines that would be able to locate specific signal waveforms stored in various storage mediums (i.e., floppy disks, hard disks, etc.) and store them in a standardized format.

A87-173. TITLE: Improved Optical Materials and Materials Processing Methods for Eye Protection

DESCRIPTION: The need for eye protection for combatants is currently provided by goggles that use polycarbonate lenses. To improve the versatility of such lenses, new transparent materials are needed that are hard, scratch-resistant, lightweight, transparent throughout the visible region, easily coated, and readily available. New concepts for ballistic lenses are desired. Such concepts should also address the practicality of being reproducible in production. The capability of being a corrective lens is desirable.

A87-174. TITLE: Radiographic Layer Counter for Composites

DESCRIPTION: The Army helmet is a composite composed of layers of resin-bonded Kevlar. Currently, verification of the integrity of the helmet is by ballistic testing. This project requires the development of a hand-held instrument, possibly containing a radiographic energy source, to determine the number of layers of Kevlar at any particular location in the helmet.

A87-175. Ballistic Face Shield with Deicing/Defogging Capabilities in Extreme Climate

DESCRIPTION: The Explosive Ordnance Disposal (EOD) Community is currently being outfitted with an EOD Body Armor System to protect against fragmentation from military munitions and Improvised Explosive Devices (IED). EOD Body Armor System includes a face shield that attaches to a chest plate and rests in a pocket on the front of the jacket. The face shield is a composite structure consisting of 3/8" acrylic and 1/4" polycarbonate laminated at the interface with a thin polyurethane film. Extreme climate conditions limit the use of the system. Ice and fog build up in arctic conditions (-30 degrees F) along with fog build up in tropic conditions (100 degrees F at 90% RH) impede the vision of the wearer, not allowing him to complete his mission. The need is for a ballistic faceshield that eliminates ice and fog build up in these extreme climate conditions.

A87-176. TITLE: Energy Absorber for High Speed Airdrop

DESCRIPTION: Future Army personnel airdrops will require higher aircraft speeds (up to 250 knots) at time of jump to decrease ground fire vulnerability. The current Army 150-knot airdrop system does not provide sufficient protection for the paratrooper from the high, opening-shock force at higher speeds. A small, light weight, energy absorption device between the parachute and the paratrooper is needed. This project calls for the design, manufacture and lab-test of such a device.

A87-177. TITLE: Thermo Electric Fan

DESCRIPTION: There is an Army requirement to circulate the heated air produced by non-electric military standard heaters. Current standard military tent/barracks stoves only have the capability to transfer heat by radiation and natural convection in which heated air rises to the top of the tent creating substantial vertical temperature gradients. The objective of the work is to develop a thermo-electric tent fan that converts a portion of the heat output of the standard Army tent/barracks heaters, through the use of thermo-electric modules, into 5 watts minimum, of electric power to rotate a fan to produce at least 390 CFM air flow. The thermo-electric power unit will also have the capability to provide electric power (5 watts) for lights, radios, and other low power electric equipment. This auxiliary power can be supplied by disconnecting the fan or providing an additional power unit.

A87-178. Target Acquisition Reduction Evaluation of Camouflage for Personnel

DESCRIPTION: To date, the evaluation of camouflage measures have been subjective. This project will attempt to provide an objective means of determining the increased survivability of a soldier provided by the camouflage pattern being evaluated. An algorithm is needed to permit the objective determination of Target Acquisition Reduction (TAR) afforded by camouflage to personnel in various environments. This proposal should include probability of detection capabilities, commensurate with the present state-of-the-art, and result in an objective method for the assessment of camouflage effectiveness.

A87-179. TITLE: Radar Signature Reducing Fabric

DESCRIPTION: This project is to develop a fabric suitable for uniforms, parachutes, and other personnel items that would provide a stealth-like capability against radar detection. This protection would be accomplished by reducing the radar signature by reflecting, scattering, or absorbing microwave energy in a manner similar to that of the surrounding environment. Additional desirable characteristics of the fabric include; suitability for printing with camouflage patterns to provide protection against visible and near-infrared detection, flame protection, and overall durability.

A87-180. TITLE: Integrated Lightweight Combat Boot

DESCRIPTION: There is a requirement to develop a lightweight combat boot to protect the soldier from chemical and environmental threats, while still providing necessary traction and comfort. Ballistic and fire resistant materials will be incorporated into the design. The boot will partially or completely eliminate the need for chemical protective overboots depending on degree of protection capabilities. The boot will be for both temperate and desert environments, provide easy donning and doffing and be part of

the chemical protective ensemble.

A87-181. TITLE: Real Time Method to Determine Even Deposition of Fungicide in Textiles

DESCRIPTION: Clothing, uniforms and textiles that are in storage can be damaged or destroyed by mildew and fungus. A means of preventing this deterioration is by application of suitable fungicides such as copper-8-quinolinolate or 2, 2^1 methylene bis-4-chlorophenol. A critical factor in the success of this method of treatment is the evenness of distribution of fungicide on the material. Currently there is no method available to measure this uniformity. This project is to develop a nondestructive and nondamaging method of determining the uniformity of applied fungicides on textiles.

A87-182. TITLE: Combat Vehicle Track Temperature Sensor

DESCRIPTION: The tracks and track pads of combat vehicles undergo build-ups in temperature in excess of 300 degrees F. The work described here requires that a non-contact sensor be developed to measure track temperatures. The sensor must be ruggedized to withstand the harsh environment, be capable of providing continuous temperature readings, have an output of 0 - 5 volts, and provide temperature readings accurate to +/- 10 degrees F.

A87-183. TITLE: Diesel Engine Fuel Consumption Measuring System

DESCRIPTION: Provide a system that can be temporarily installed in the vehicle fuel system to measure fuel consumption during field operations. The measuring system should not significantly alter normal vehicle operation. The system will have the capability of measuring the mass flow consumption rate over the range of a few pounds per hour (pph) to 1300 pph. System power will be supplied at 28VDC and the output signal should be in the 0 - 5 volts range with a 2.5% error in the consumption measurement.

A87-184. TITLE: Mechanical Shock Sensor

DESCRIPTION: A need exists for a passive (i.e., self-contained, non-electronic) mechanical device that is reasonably inexpensive to be used to measure ballistic shock. Velocity changes in the range of .1 to 50 meters/second need to be measured. A device using the "Taylor technique" (used to determine dynamic yield strength by measuring deformation of cylinders impacted at known velocity) or an improvement of the "Multiple Mechanical Gage" developed by NOL (see NOL Technical Report 67-151, available through DTIC) might be appropriate, if the gages could be made cheaply and read easily. If a peak acceleration technique were used, a 10 KHz frequency response (not a 10 KHz resonance) would be desirable, and an acceleration range of 100 to 20,000 g's would be desireable.

A87-185. TITLE: Ballistic Shock Simulator

DESCRIPTION: A need exists for a machine capable of simulating high frequency mechanical shock transients. A technique (preferably non-pyrotechnique) for generating transient velocity changes of .1 to 50 meters/second, containing high frequency acceleration levels (100,000 to 1 million g's at 100 KHz to 1 MHz) to a test item of 1 to 100 Kg is needed. The only known device capable of approaching these requirements is a large, outdoor, pyrotechnique facility run by IABG in West Germany.

A87-186. TITLE: Improved Blast Overpressure Transducer

DESCRIPTION: A need exists for an improved blast overpressure transducer to operate in the 1 - 100 KPa region. It is desired that this transducer be of "blunt cylinder" configuration, with the sensing membrane flush with the top surface for clean aerodynamic coupling. DC frequency response is needed for ease of calibration. An upper frequency response of 100 KHz with no overshoot, or 300 KHz if undamped is desired. The transducer must be capable of driving 200 meters of cable with at least 50 KHz frequency response. Very low sensitivity to acceleration and thermal effect is needed. See report number APG-MT-5481 "Improvement of Air Blast Measurement" by W. Scott Walton (March 1981), which is available through DTIC, for a description of the limitations of transducers currently available.

A87-187. TITLE: High Output Microbial Aerosol Generator

DESCRIPTION: A requirement exists for a field aerosol generator for operational detection and decontamination testing. The aerosol generator must produce droplets with aerodynamic diameters between 2 - 5 micrometers with microbial suspending fluids (1 g/cm). Output capacities must be between 500 - 1000 ml/min at pressures around 75 PSI. Multiple nozzle capability should be incorporated into the design.

87-188. TITLE: Real Time Smoke and Aerosol Analyzer

DESCRIPTION: The current method of measuring smoke and aerosol mass concentrations using filters and bubblers is both labor intensive and slow. The development of an inexpensive, portable instrument capable of continuous sampling and real time analysis for use in the field is desired. The use of light scattering as the quantitative tool is undesirable because the wide range in particle size distribution, shape and obscurant material (both liquid and solid) would make calibration difficult. Among other possibilities, photo acoustic spectroscopy or magnetic susceptibility, etc., might be useful as quantitative tools.

A87-189. TITLE: Meteorological Influences on Smoke/Obscurant Effectiveness

DESCRIPTION: The U.S. Army conducts smoke/obscurant field tests to

determine the relative screening effectiveness of different smoke/obscurant materials or dissemination systems and to identify degradations in effectiveness that occur over time as a result of storage (stockpile reliability). Screening effectiveness is documented by electro-optical measurements, photographic coverage, meteorological measurements, and observer responses. Comparisons of screening effectiveness for different materials or systems and for the same material or system before and after storage are complicated by the fact that the effects of trial-to-trial variations in microscale to mesoscale meteorological conditions can mask significant differences in performance. To assist in these comparisons, there is a need for a reliable, objective, and quantitative means to account for meteorological influences on apparent smoke/obscurant effectiveness.

A87-190. TITLE: Laser Testing on Open Ranges

DESCRIPTION: Lasers can be used in field testing of battlefield obscurants to characterize the obscurant properties and to determine how the lasers are defeated by the obscurant. In realistic situations, test ranges up to 5 km may be encountered. Wavelength from ultraviolet to the far infrared are used.

The hardware for both generating the laser signal and for measuring the effects of the obscurant, i.e., attenuation, scattering, bending, blooming, must be developed. Operating procedures and safety contrasts for personnel and wildlife must also be developed.

A87-191. TITLE: Wind Tunnel Development

DESCRIPTION: A continuing mission of DPG is to sample airborne particulate material in field tests. Before conducting field test for particulate materials, samplers must be calibrated to determine their collection efficiency. On-going requirements exist for evaluation of smoke/obscurant source burn rates and expenditure testing. In the past, the existing wind tunnel facility at DPG has been used to perform those functions. Results indicate that the tunnel facility has many uncontrolled factors that are limiting its usefulness. Nonuniformity in the wind stream and particulate concentration can be considered to be contributing to the uncertainty of the results. Also, a more efficient method for disseminating particulate material into the tunnel must be developed. The instrumentation for the wind tunnel is inadequate and should be updated for accuracy, control and efficiency.

A87-192. TITLE: Infrared Radiance Instruments

DESCRIPTION: Instruments to measure the infrared radiance of background, targets, an obscurant cloud at various wavelengths, similar to instruments available for measuring luminescence in the visible part of the electromagnetic spectrum are required.

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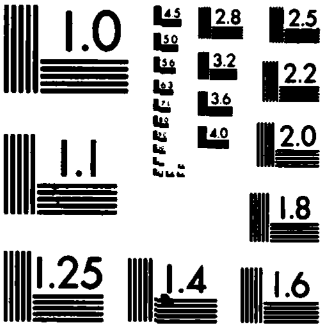

MICROCOPY RESOLUTION TEST CHART
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Data on radiance and contrast in the infrared region are frequently critical for determination of the performance of various types of electro-optical devices. They are also useful for the purpose of mathematical modeling. They are also used to determine the absorptive and radiative characteristics of obscurants.

Automated instruments that have high repeatability and self-contained calibration systems need to be developed.

A87-193. TITLE: Tracer for Visualization of Physical Removal of Warfare Agent Simulants

DESCRIPTION: Spraying a vehicle with a high pressure water jet to remove chemical warfare agent contaminant is an example of physical removal. Effectiveness of proposed decontamination devices of this type can be quantified on a laboratory scale through techniques such as extraction or even direct weighing of the test surface at appropriate intervals. The purpose of the proposed work is to develop a tracer material which can be added to agent simulants employed in large scale decontamination testing or training on vehicles. Operators should be able to see the tracer disappear as simulant is removed. Means suitable for use in remote areas must be developed to determine amount of tracer present and relate that to mass/meter^2 of simulant remaining on the test vehicle.

A87-194. TITLE: Image Analysis Enhancement for Counting Fibers and Florescent Particles

DESCRIPTION: This study will support outdoor diffusion trials and NBC contamination/decontamination programs requiring the use of fluorescent particles. The current method of fiber counting and fluorescent particle analysis is tedious and physically tiring. A requirement exists to utilize current image analysis instruments (Zeiss IBAS 2000, or Cambridge Quantimet 920) and develop software/hardware to be able to efficiently count fibers and fluorescent particles.

A87-195. TITLE: Quartz Crystal Delta-Temperature System

DESCRIPTION: Dugway Proving Ground performs testing in the ambient atmosphere where micrometeorological measurements are required. A prime measurement requirement is for temperatures at 2, 4, 8, and 16 meters, to be used in gradient computations. Current temperature measurement accuracy is limited to 0.1 degrees Celsius. Accurate gradient computations require measurement accuracies near 0.01 degrees Celsius. The current temperature measurement systems provide voltage outputs, and accuracy is limited by noise on the order of 60 millivolts. Quartz crystal thermometers use changes in crystal oscillation frequency to measure temperature. Because the output is a frequency rather than a voltage, line losses and random millivolt noise have no effect on data accuracy. This would permit temperature measurement accuracies near 0.01 degrees Celsius.

determine the relative screening effectiveness of different smoke/obscurant materials or dissemination systems and to identify degradations in effectiveness that occur over time as a result of storage (stockpile reliability). Screening effectiveness is documented by electro-optical measurements, photographic coverage, meteorological measurements, and observer responses. Comparisons of screening effectiveness for different materials or systems and for the same material or system before and after storage are complicated by the fact that the effects of trial-to-trial variations in microscale to mesoscale meteorological conditions can mask significant differences in performance. To assist in these comparisons, there is a need for a reliable, objective, and quantitative means to account for meteorological influences on apparent smoke/obscurant effectiveness.

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DESCRIPTION: Instruments to measure the infrared radiance of background, targets, an obscurant cloud at various wavelengths, similar to instruments available for measuring luminescence in the visible part of the electromagnetic spectrum are required.

A 4-level temperature/temperature differential measurement system based on quartz crystal technology would be of great interest to the Dugway Meteorology Branch and other agencies engaged in micrometeorological measurements.

A87-196. TITLE: mm-Wave Radar for Cloud Mapping

DESCRIPTION: A record of the internal structure of smoke obscurant clouds generated during tests would be of value. Millimeter wave radar with 7.5 meter range resolution and 0.5 degree angular resolution may be an appropriate technology for this purpose. Investigation of optimum frequency, optimum generated power, and the effect of polarization on backscatter is required. Development of empirical relationships between backscatter intensity and smoke concentration for various smokes is needed.

A87-197. TITLE: Vapor or Aerosol Decontaminate for Chemical Warfare Agents

DESCRIPTION: Current methods of decontamination use strong bases or oxidizers to wash contaminated surfaces. These methods are very destructive to reactive metal surfaces and to sensitive components, such as electrical and optical devices.

It is also difficult to decontaminate interior spaces with limited access. The development of an effective non-corrosive decontaminate that can be applied as a vapor or as an aerosol fog and that doesn't need to be washed off is desired.

A87-198. TITLE: Aerosol Sampler for Fibers

DESCRIPTION: Materials with high aspect ratios (fibers) are being developed as obscurants. No suitable method exists where these materials can be collected on a scanning electron microscope grid for timely physical characterization. Fibers with aspect rations of 2 X 10^3 (2 micrometers X 4 X 10^3mm) must be sampled without physical damage.

A87-199. TITLE: Wind and Energy Budget Measurement System for Desert Terrain

DESCRIPTION: An innovative meteorological measurement system is needed to provide ground truth data for remote sensing of surface temperatures and energy budgets over desert terrain in support of test missions. Automated instruments for easy deployment in mountainous terrain at ten remote sites are required to measure wind speed and direction, longwave and shortwave radiation, soil temperature and moisture, air temperature and relative humidity. The system should include a two second sample frequency with on-site data storage capabilities. Data are stored in digital form on cassette tape during specified field programs and later processed on a VAX 11/785 computer at a command center.

A87-200. TITLE: In-Flight Vehicle Attitude Measurement

DESCRIPTION: A method of accurately measuring the attitude angles (pitch, yaw, and roll) of vehicles in flight. The types of vehicles of interest include rockets, projectiles, and fixed and rotary wing aircraft. Priority will be given to methods which do not require equipment on board the vehicles. Measurement accuracy in the neighborhood of 0.1 degree in each axis is required. Vehicles in flight will be at altitudes from near ground level to 100,000 feet. Measurements are required while the vehicles are under going tests. Velocities will range from hovering helicopters to missiles traveling at rates as high as 15,000 feet per second.

A87-201. TITLE: Real-Time Image Processing System

DESCRIPTION: Methods for performing real-time (60 frames/sec) image processing are required. Hardware architectures that process all pixels in a single raster scan in paralled is envisioned. Simultaneous multiple raster scan processing is desired to increase speed and permit the use of processing techniques such as median filtering. Processing techniques to be used with the computing hardware are required. Feasible image processing techniques that are feasible on the designed hardware shall be identified. The entire system will be used to improve images that are used by an automatic target image tracking system employed for missile test range instrumentation. The image trackers are used to track missiles, rockets, and aircraft in flight.

A87-202. TITLE: Development of "Smart Robot" for Fast Burst Reactor Maintenance

DESCRIPTION: Research into the concept of remotely controlled robotics for service and maintenance of fast burst reactors. The robot would be operated in a high radiation environment.

A87-203. TITLE: Multi-Sensory Tracking Mount Control

DESCRIPTION: A test range instrumentation tracking mount will be equipped with TV, IR, millimeter wave radar, and telemetry tracking sensors. Development of a comprehensive algorithm to use outputs from all of these sensors simultaneously for tracking mount control is planned. Techniques of real-time adaptive parallel processing are desired. Algorithms, parallel processing hardware configurations, and software specifications for the final system design are needed.

A87-204. TITLE: Signal Security for Video (Television) Signals

DESCRIPTION: WSMR has a requirement to relay real-time television signals containing classified scenes from remote areas to the Range Control Center in a secure manner. A system is required to provide signal security for fiber-optic or microwave transmission of these real-time television signals. The proposed system shall have the following characteristics:

a. Utilize and be compatible with data rates of National Security Agency (NSA) encryption devices.

b. Provide signal security for National Television Standards Committee 60 fields/second, 525 lines/frame color video signals.

c. The transmit end of the system shall accept a one volt peak-to-peak analog video signal as an input and provide output signal compatible with an NSA encryption device.

d. The NSA decrypter on the receive end of the system shall accept the encrypted signal and output the original one volt peak-to-peak analog video signal.

e. Have two 15 KHz bandwidth secure analog channels.

f. The system may employ video compression techniques.

g. Be compatible with existing WSMR video data reduction criteria.

h. Be video scene independent.

i. Accept and process playbacks from video tape recorders that are not time base corrected.

j. Be compatible with existing digital data range transmission standards, i.e., T1, T3, etc.

A87-205. TITLE: Real-Time Measurement of HCl Gas

DESCRIPTION: There is a need to perform real-time measurement of HCl gas in the ranges of 0.10-10.0 ppm and 1.0-100 ppm. HCl is a component of certain missile exhaust gases. In certain concentrations and durations, there is a severe health hazard to personnel. The instrument must be capable of quantifying the concentrations of HCl over short time intervals of 1-10 seconds, 1-30 seconds, and 1-60 seconds. The time for the instrument to rise to 90% of the maximum value should be less than one second.

A87-206. TITLE: Feasibility of a Mobile Drone Formation Control System (DFCS)

DESCRIPTION: Provide an analysis of duplicating, to a maximum degree, the WSMR DFCS as a fully mobile land based target control system. Provide a feasibility concept and preliminary design for such a system if practical.

A87 ./. TITLE: Mobile RF Interferometer Antenna Array (2.2-2.4 GHz)

DESCRIPTION: The current interferometer antenna arrays are fixed placements and are limited to specific areas of coverage. Studies have indicated that an array that would lie within an area of 30 feet by 30 feet would provide the required accuracy for short range coverage. However, there does not exist data to support the feasibility of such a small array. Also, to provide the required accuracies, the relative positions of the antennas within the array must be maintained to within 3 millimeters both in vertical and in horizontal directions. The desired result of such a study would be the design of an antenna array that would meet the mobility requirements as follows:

a. Disconnect from receiver equipment and ready for transportation shall be less than four hours.

b. Deployment and hookup at a new tracking site shall be less than four hours.

c. The volume of coverage shall include the following: Azimuth - 360 degrees and Elevation 0 to 90 degrees.

d. The array, when in the transport mode, will meet the size and load limitation requirements of the Department of Transportation of New Mexico.

A87-208. TITLE: Telemetry Digital Tracking System Research

DESCRIPTION: The thrust of this research is to determine to what extent and how the two types of telemetry tracking systems, each having two distinct servoloops, can be upgraded to purely digital tracking system. All tracking modes shall be treated. The constraints shall be as follows: Each pedestal, pedestal load, torque motors and gearboxes shall remain the same. If the analog tachometers cannot be eliminated as part of this research, the same units in each system must be used. Servo parameters needed for this research effort must be derived by the researcher using empirical methods. Performance objectives of the upgraded systems shall be as follows: The transient response of the systems and the tracking error coefficients shall be at least as good as the present systems with some improvement expected. At least an order of magnitude improvements shall be demonstrated in drift and in the frequency-of-adjustment of components. Other deliverables shall be as follows: Stated space simulation models used in this research effort shall be provided with full documentation and in such a form as to be executed on a Wyse PC (MS-DOS Ver. 2.11) and this shall be demonstrated. A full market research of components satisfying the design shall be provided with components specified in detail where commercial items are not available. A final report shall be provided presenting the development, design, simulation model, simulation results, market survey, and any specifications.

A87-209. TITLE: Microcomputer-Network Architecture for Range Instrumentation Applications

DESCRIPTION: Research to date has demonstrated the feasibility and potential of the innovative concepts (1) cascadable microprogrammable microcomputer modules for real-time signal and image processing and real-time range instrumentation control applications, and (2) retargetable automated microcode generator systems. The cascadable module is a basic building block, an 8/16 bit word increment microcomputer module, which when incorporated with real-time signal processing capability can be microprogrammed and serially concatenated to form a computing system up to 64-bit word. The code generator is to automatically generate microinstructions for application programs from high-level language for the cascadable modules. The utilization of modules and the code generator development tools as standardized items in the acquisition of microcomputer-based computing network/system offers not only considerable flexibility to meet processing requirements but also significant potential

economic savings.

Exploratory development is now needed to study, design and develop computing network architectures, utilizing cascadable modules and code generator development tool as standardized basic items, for processing range and range rate data, real-time Kalman filtering, real-time target motion resolution (TMR) processing of MPS-36 and FPS-16 radars data, and for processing image/pattern information for real-time tracking control of optical trackers.

A87-210. TITLE: High Speed Cascadable Signal Processing Circuits

DESCRIPTION: Signal Processing algorithms are multiply/accumulate intensive. Novel methods using advanced IC devices are needed. Radar digital signal processing and spread spectrum processing task include FFT, LMS, L, convolution and spectrum analysis. As examples, 32 X 32 multiplier, 64 X 64 multiplier, paralled multiplier and floating-point processing architectures are sought for processing speeds at 10 nanosecond. Microprogrammable designs are necessary.

Clock speeds to 30 megahertz are expected with microprogrammable microcomputer cascadable modules. The cascadable module is a basic building block, an 8/16-bit word increment module, which when incorporated with real-time signal processing capability can be microprogrammed and serially concatenated to form an ultra-high-speed computing system up to a 64-bit word.

Exploratory development is now needed to design and develop specialized high speed cascadable signal processing circuits for cascadable modules to process range and range rate data, real-time Kalman filtering, real-time target motion resolution (TMR) processing of MPS-36 and FPS-16 radars data, and processing image/pattern information for real-time tracking control of optical trackers.

A87-211. TITLE: Digital Filtering Using Simulation Models

DESCRIPTION: Real-time digital filtering algorithms frequently use simple polynomial process models. In the past, this has been necessary due to speed constraints. The advent of much higher speed computing machinery makes it possible to use a much more complex process model such as a missile flight simulation. These models tend to be vehicle specific and lacking in flexibility. Algorithms and computer architecture are needed to permit the use of missile simulation process models that are flexible, high speed, and user friendly. Data rates up to 15KHZ are required. Computing systems must be small for use in fielded test range instrumentation.

A87-212. TITLE: Computer Architecture for Kalman Filtering

DESCRIPTION: Apply innovative techniques to the development of a new computer architecture for real-time digital filtering using Kalman filter

principles. Multidimensional filtering is required at sample rates of up to 15KHZ for real-time output. Parallel processing techniques are required to achieve the needed speed. Architectures using state-of-the-art chip technology are sought for application to the next generation of instrumentation radar and telemetry equipment.

A87-213. TITLE: Development for High Intensity Solar Facilities for Simulating Thermal Nuclear Environment

DESCRIPTION: Research into solar thermal facilities concepts for simulation of the nuclear thermal pulse is required. Effort should be directed toward large test areas (about $0.5M^2$) and high thermal fluxes (about 300 $cal/cm^2.sec$).

A87-214. TITLE: Noise Abatement for Artillery Weapons

DESCRIPTION: Determine the feasibility of using noise abatement schemes and procedures for reducing or eliminating the effect of artillery weapons firing on nearby communities. Noise pollution is a continuing problem for all government installations generating high intensity, low frequency noises such as found in large caliber weapons firing.

A87-215. TITLE: Protective Barriers for Explosive Operations

DESCRIPTION: Develop a new equipment and method for fabricating barriers to be used between temperature conditioning units for explosive materials. These barriers would prevent the propagation of a conflagaration between units in case of an accident. These barriers would improve the safety of operations in the vicinity of the temperature conditioning units.

A87-216. TITLE: Evaluation of Large Caliber Projectile Function

DESCRIPTION: Devise new methods for the evaluation of the grenades in modern high explosive large caliber projectiles. The present methods are manpower intensive and contain a large element of personal risk for those involved. The present methods required that people walk upon the impact field searching for unexploded munitions and then to determine the probable failure mode for the munition. The primary risk is that of unknowingly stepping upon or disturbing a dud while searching for them. The new methods must reduce risk while maintaining the ability to evaluate the performance of the round.

A87-217. TITLE: Projectile Velocity Measurement for Large Caliber Weapons

DESCRIPTION: Determine the best of the available and feasible projectile velocity measurement techniques for large caliber projectile firings.

A87-218. TITLE: Reduction of Ground Loops in Instrumentation Vans

DESCRIPTION: Devise new methods and procedures for eliminating or reducing the affects of ground loops within the components of instrumentation systems. The problems are most severe with portable electronic instrumentation vans used on a variety of weapons systems tests. Many of these ground loops arise because of (1) the large distance between the measured phenomenon and the instrumentation equipment (2) the large power requirements for electrical power near and at the test site that affects the local ground potential, and (3) safety grounds requirement associated with high explosive munitions.

A87-219. TITLE: Chemical Agent Simulation in Cold Regions

DESCRIPTION: In testing NBC collective protection systems in cold environments, a chemical agent simulant is needed that has sufficient vapor pressure to be a threat at temperatures as low as -25 degrees F. The simulant must be easily detectable and capable of being quantified by simple instrumentation that does not require laboratory support. This task would be to research and designate one or more suitable non-toxic chemical simulants along with dispensers and the detection and quantification equipment to allow realistic chemical simulant challenges to collective protection systems in cold environments. All simulant dispensers and instrumentation must be simple, portable and operable down to -25 degrees F and under conditions of low absolute humidity. Instruments may be powered by either 110/220 v.a.c. power, or by low temperature batteries. This simulant chosen should provide a reasonable simulation of a non-persistent chemical agent and have filtering characteristics to known threats agents. A simulant detection sensitivity of at least one microgram per liter is desired.

A87-220. TITLE: Cold Regions Trafficability Kit

DESCRIPTION: A trafficability kit is needed to quantitatively measure vehicular trafficability in cold regions. The kit would allow a more accurate and objective means of establishing trafficability parameters in snow, ice and on frozen surfaces. This task would research cold regions trafficability and develop a field kit and instructions for its use.

A87-221. TITLE: Velocity Reference for Testing Inertial Systems

DESCRIPTION: Ground-based test range instrumentation has been unsuccessful at providing velocity estimates that could serve as a reference for testing state-of-the-art airborne inertial systems integrated with other navigation aide (GPS, LORAN, etc.). The classic approach is to use a time history of position measurements from one or several sources combined in some optimal or suboptimal way to estimate first and second derivatives. Direct measurements of velocity are required to improve these estimates beyond the 0.1m/sec accuracy achievable with inertial systems. It is highly desirable to use existing range instrumentation to provide the necessary

measurements. One or more Doppler measurement sources is a possible solution, provided a single scattering center can be resolved and tracked. Research testing and procedural development is required to augment existing position measurements with velocity measurements of a single scattering center on any aircraft or projectile. Velocity measurements must be good enough to allow optimal estimation algorithms to compute three-axis velocity estimates with accuracy on the order of 0.05 m/sec throughout high dynamic (up to 9g) maneuvers.

A87-222. TITLE: Parallel Output Imaging Sensor

DESCRIPTION: A highly parallel output imaging sensor is required for very high speed (>2000 fps) video applications. The sensor would need to be an area-type sensor consisting of approximately 256 x 256 pixels in rows and columns. Charge coupled elements (or similar devices) would be used to read out all (or most) of the rows simultaneously in parallel to separate pins. To accommodate the large number of pins, it is anticipated that the device would be mounted in a pin-grid array package.

A87-223. TITLE: Parallel Solid State Video Recorder

DESCRIPTION: A highly parallel input video recorder is required to accommodate the high-data rates associated with high-speed parallel output image sensors. The recorder would be similar in concept to frame grabbers with a common clock but would employ up to 256 separate inputs. Each input would require 'an A/D recorder and associated memory. Upon receiving a freeze command, the recorder should retain 1000 to 4000 image frames and be capable of transferring the memory contents to standard video output. Important recorder parameters would be recording speed and physical size.

A87-224. TITLE: Desert Mobility Course Selection for Correlation with Probable Operational Requirement

DESCRIPTION: World-wide desert terrains have been classified using the Waterways Experiment Station physiographic association using random sampling. It is, therefore, possible to reasonably compare one terrain region to another in terms of general cross-country mobility. The correlation for a specific route, however, is also affected by the fact that some terrains will operationally be more utilized/avoided than others and existing roads will be used to a large extent, especially by support vehicles and in mobility-restricted areas. Previous correlations have been based on examination of world-wide desert road networks, but these need to be updated based on presently existing road conditions and tactics. These correlations will be used to generate test mileages required on the existing specific desert mobility test courses to emulate the actual probably operational movement. Correlations are needed for all classes of Combat/Tactical vehicles for the major desert areas of the world.

A87-225. TITLE: Applications of GPS to Ground Target Control

DESCRIPTION: The Global Positioning System, GPS, offers the ability to provide basic position information needed for remote control of ground target vehicles. Vehicles to be controlled simulate enemy tanks, trucks, and other similar targets. They will be both surplus military vehicles like the M-47 tank, M-113 Armored Personnel Carrier, or M-880 Utility Vehicle and specially adapted commercial vehicles. Speeds will be up to 60 mph and required position repeatability should be on the order of 2 meters or less. Control systems will be of two types: a completely automatic system in which the target vehicle is remotely controlled over a pre-determined course (either pre-driven or designated by coordinates), or a system using the GPS to provide real time position information for manual control. Scope of effort includes analysis of achievable accuracies and limitations of such a control system.

A87-226. TITLE: Directions in Target Performance Requirements

DESCRIPTION: Design effort which defines the "target of the future". The projection of technology and weapon system developments in the next 20 years are analyzed to predict the trend in requirements for aerial, and ground target vehicles which are utilized to represent the threat in test and evaluation of new weapons systems. Needed technology for ancillary equipment such as control systems, recovery systems, and etc. should also be covered. Key parameters are identified and future requirements and technology needed to achieve them are predicted. This effort can concentrate on aerial targets, ground targets, or both.

A87-227. TITLE: Mobile Target Near-Miss Scoring System

DESCRIPTION: A scoring system is required for remote control target vehicles which will locate and score 105 mm and larger projectiles passing within 100 feet of the system to an accuracy of 1 foot. The scoring information would be transmitted over telemetry links (either GFE or designed into the system) in real time to a display or into a GFE computer. The purpose is to have hit and near-miss information available at the firing site immediately after the round is fired. Any components mounted on the target vehicle must be rugged and no larger than 4 cubic ft in volume. On board power is available.

A87-228. TITLE: Flexible, Dynamic IR Target

DESCRIPTION: A programmable device is required to provide a realistic, three-dimensional thermal target which can simulate the IR signature of various vehicles. The system should be large enough to simulate the M1 tank and have a thermal resolution of approximately one degree C, and a desired cell size on the order of one inch by one inch. For example the target could be composed of individual heated areas of one square inch which can be programmed to individual temperatures of plus or minus one degree C. The entire structure should be capable of mounting on a one half

ton pick-up truck which is driven over rough terrain by remote control. Power required should not exceed 40 kw.

A87-229. TITLE: MM Wave Signature Generation

DESCRIPTION: Targets are needed which can be configured to provide a mm-wave radar return which simulate various ground vehicles such as tanks, armored personnel carriers, and trucks. Such areas as the double doppler return from tracked vehicles should be considered. Target is to be low in cost and be able to be mounted on a one-half ton pick-up truck which is driven over rough terrain by remote control.

A87-230. TITLE: Techniques for Large Scale, Ground Target Presentation

DESCRIPTION: Remote control systems and staging techniques are required to provide presentations of up to 60 unmanned target vehicles over large areas. Vehicles will be in line on a road with spacing of 150 feet or less and in parallel waves over unimproved terrain. Safety requirements are to be included to prevent vehicle run-away or collision. System concept should be portable and allow speeds up to 60 mph on paved roads with appropriately reduced speeds over rough terrain.

A87-231. TITLE: A Methodology for Predicting Target Requirements

DESCRIPTION: Develop a methodology to predict the numbers and types of ground targets, and aerial targets for US Army test and evaluation. This technique would allow the determination of quantities and types to stock for use in system test and evaluation to avoid target production delays and at the same time minimize stockage and associated cost.

A87-232. TITLE: Radar Evaluation Handbook

DESCRIPTION: Personnel who are not expert in the field of radar are being briefed on systems which include radars. The systems may be instrumentation systems for use in testing weapons or weapon systems which include radars.

A handbook is required which, while having a firm technical basis, can be used by a person with only a general technical background as an aid in making a competent technical evaluation of a radar and of a system which uses radar.

A handbook should allow the user to determine which radar capabilities are important in the end use of the system. The user should be able to refer to the handbook to learn which radar specifications are necessary to evaluate the ability of the radar to meet its requirements. In addition, the user should be able to determine which radar specifications will be easily met, and which are of relatively high-risk. Radar frequencies covered should include 10 to 140 GHz.

Included in the handbook, as appendices, should be discussions of assumptions, of theoretical and practical calculations which form the bases of the main text, tables of radar cross sections of typical targets of interest to the Army (artillery shells, ordnance, vehicles of various types), notes on radar parameters which rarely change, sensitivity analyses indicating which parameters are more important than others in affecting radar performance in the particular type of system being evaluated, and rules of thumb which can be confidently applied to the evaluation. A discussion of multi-path, its effects, and conditions under which it may be a problem should be included.

Radars which will be evaluated with the aid of this handbook will include ground-to-air instrumentation radars tracking munitions in flight, ground-to-ground instrumentation radars tracking low-flying munitions or ground-based vehicles, and air-to-ground radars seeking or tracking targets at depression angles from 20 to 90 degrees.

A87-233. TITLE: Target Area Monitoring System

DESCRIPTION: In the near future, the Army will be conducting tests in which multiple small objects will be in the air over an array of vehicles which are on the ground. A system is required which will locate and then monitor the movement of both the objects in the air and the targets on the ground. Output of this system should be trajectory data indicating the relative locations of both the objects in the air and the targets on the ground. The output need not be in real-time, however, but may be the result of post-processing of data.

The vehicles may be fitted with transponders or beacons, if required. The small airborne objects have practically no space aboard for extra equipment, and nothing may be fastened to the outside, which would affect their ballistic flight paths. It is desirable that the system operate in the presence of dust, smoke from fires, modes rain rates, snow and fog.

In particular, an instrument is required to accurately measure the relative separation of several submunitions when ejected from a rocket, or artillery shell carrier. It is desired to measure the differential position to within 0.3 meters and the differential velocity to within 0.3 meters/second for the period of time during ejection of the submunition from the carrier, until stabilized flight is achieved. It is preferred that nothing be required to be carried in the submunition itself, but approaches using such a technique will be considered if no better method is proposed. No manned instrumentation sites are allowed within 1 km of the function point for safety reasons.

A study of how this task might be accomplished is solicited. A successful study might lead to an exploratory development effort. The study shall result in a report of the investigations made and conclusions. If a candidate system is proposed, a technical discussion shall be included in the report to show why the investigator believes the system would perform the task.

A87-234. TITLE: Radiometer Beam Location System

DESCRIPTION: The Army is currently developing small munitions which include passive radiometers operating at millimeter wavelengths. These munitions search the ground using the radiometer in order to sense targets. A system is required which will locate where the radiometer is pointed at any time.

The system might be one which would respond only when it was in the field of view of the radiometer, or it might be one which would locate a radiometer's beam from afar. The system itself must not interfere with the radiometer's search for targets, nor appear as a target to the radiometer. A system which illuminated the radiometer at some frequency to which the radiometer was insensitive would be acceptable.

Output from this study shall be a report on all of the designs considered with special emphasis on system designs which may meet the requirements listed above. A technical discussion of any systems being proposed and of their capabilities shall be included. Preliminary instrument development might be a follow-on program to this effort.

A87-235. TITLE: Bayesian Reliability Assessment Techniques with Application Examples

DESCRIPTION: The complexity of weapon systems has increased, and more functions are accomplished by various electromechanical devices. Parallel to this, development and testing costs have increased. Also, the rapid development of technology demands a shorter development cycle for new equipment. The 10- to 15- year cycle of the past results in production materiel that is technologically outdated by the time it is fielded. All of this results in higher levels of reliability being required of materiel and less test time being available to assess whether those levels have been achieved. Classical reliability testing approaches require more time and resources than are normally available. Bayesian approaches seem to offer an avenue that would better provide for quantitative assessment of reliability requirements within the constricted test time and resources available. Prior estimates could be based on expert judgment or on previous test results.

A87-236. TITLE: Lightning Threat Sensor and Disconnect System

DESCRIPTION: An 118-foot tall antenna pattern measurement facility arch offers an attractive lightning strike target. It is connected to high value instrumentation and processing equipment in a nearby shelter. There is a requirement to develop a system which will sense an imminent lightning strike and disconnect all power and data lines from the shelter. A conventional Lighting Protection System which would alter the electromagnetic characteristics of the arch is not acceptable.

A87-237. TITLE: Voice Jamming Effectiveness Evaluation

DESCRIPTION: The test and evaluation of voice communications electronic countermeasures systems requires subjective evaluation by test personnel. Test methodologies are required that will provide automated, repeatable testing of jammer effectiveness and eliminate the variability introduced by human listeners.

A87-238. TITLE: Processor-controlled Waveform Generator - To - Amplifier Interface

DESCRIPTION: Design, build and test a processor-controlled interface for application between a .1 - 40 Ghz arbitrary waveform generator and a set of n high power amplifiers (HPA) and antenna systems. Functionally, the interface would include an n-port power divider, n band-pass filters and n automated pre-amplifiers. The interface must switch and control RF from the generator to n sets of HPAs/antennas at a microsecond rate. Pre-amplifier gain and HPA output power must be under control of a MICROVAX I processor. The feedback loop from HPA output must throttle the pre-amp gain to keep the HPAs linear at all times. The final package must be no more than 10 inches high and fit in a 19-inch wide rack.

A87-239. TITLE: AI Based Terrain Analysis Data Base Development from Multispectral Imagery

DESCRIPTION: Future Army digital topographic data base requirements include detailed terrain analysis information about the terrain surface, such as soil types, vegetation coverage, hydrology, etc. Currently available data bases, such as Digital Feature Analysis Data (DFAD), do not provide these kinds of information. One potentially valuable source of raw data from which to extract at least a subset of terrain analysis features is the current generation of multispectral imagery (MSI), specifically Thematic Mapper and SPOT data. The goal of this work is to use an artificial intelligence (AI) approach to feature extraction; i.e., image understanding, to explore the automated development of digital terrain analysis data bases, or subsets thereof, to meet Army requirements. Issues to be addressed include software development for proof of concept demonstrations and in-house testing at ETL; determining what features can, and cannot, be extracted from MSI; and comparing the value of the different types of MSI (e.g., TM vs SPOT) for this work. The Phase I effort will address the issue of updating and intensifying existing DFAD data sets to meet terrain analysis specifications, including use of the DFAD as a prior knowledge. Phase II work will address the more complex problem of extracting this information from MSI when DFAD is not already available.

A87-240. TITLE: Synergistic Exploitation of SAR and Map Data for Map Update and Verification

DESCRIPTION: Before knowledge of enemy force structures and doctrine can be employed to determine worthwhile target areas on synthetic aperture

radar (SAR) imagery in a broad area search operation, digital map data must be registered to the SAR image in varying degrees of precision and accuracy. The requirement under this work is to develop rules that can be enforced in a tactical environment to generate the necessary registration accuracy and precision from realistic map data. It will be assumed that the existing map data is not accurate and precise enough and that in addition to a map-to-image registration function, the analysis can make use of a SAR segmentor function capable of delineating four classes, namely fields, forests, water and urban boundaries. The analysis can also make use of a smart control generator function capable of generating map control estimates on the SAR image. The purpose of this work is to develop rules and procedures for harnessing the three functions in a test bed at ETL so that an expert system can be developed to be used in conjunction with other expert system designed to detect and classify military target clusters. It is expected that the resulting expert system will be capable of verifying map data, improving resolution accuracy and precision such as sharpening the boundary between field and forest and in general, determining point, lineal and areal feature locations, all upon demand of a controller.

A87-241. TITLE: Multisensor Record Registration

DESCRIPTION: Develop a set of capabilities leading to the automatic registration of digital multi-sensor records to one another. Consider the situation where the images are collected within T hours of one another and where exterior and interior orientation data exists to the degree that the object space centers are within a distance D of one another. Assume that map data of resolution R is available in digital form. The symbols T, D, and R are parameters of the study. In all cases, assume that the object points of interest are imaged on the pertinent records and that sufficient common imagery exists around the object points for a geometric registration. Special consideration must be given to visible imagery as well as mid-range infrared and X-band synthetic aperture radar. The resolution I of each image type are also parameters of the study. Consideration must be given to the situations where map data ranges from sufficient to nonexistent, i.e., where vision understanding methods must be used to relate corresponding image features. The purpose of the work is to develop a capability for the synergistic exploitation of multisensor data for military target identification. It is not a requirement of this work to develop the exploitation capability.

A87-242. TITLE: Representation and Recognition Techniques for Synthetic Aperture

DESCRIPTION: Research and develop efficient techniques for representing segmented synthetic aperture radar (SAR) image data, such as terrain boundary edges and terrain regions, in convenient list forms for implementation in a LISP environment. Based on computer vision and pattern recognition techniques, investigations shall be conducted to develop various methods for image structure analysis using the image data representations obtained earlier as input. The results of this image

structure analysis shall be used to develop automated and unambiguous recognition techniques for radar terrain features. The particular image data representations and structural analysis which lead to recognition will be determined. The segmented SAR image data, consisting of five categories of terrain features (water, forests, fields, urban areas, and airfield runway patterns), will be furnished by the government. Personnel and facilities of the prospective contractor must be cleared to the SECRET classification level by the designated security elements of the Department of Defense.

A87-243. TITLE: High Complexity Terrain Image Synthesis

DESCRIPTION: Computer image generation (CIG) techniques provide unique opportunities to visualize terrestrial scenes of geographic areas represented by digital map data. To date, military applications of CIG technology have focused on development of moderate-resolution (approx. 512 x 512 pixel), real-time (30-60 Hz) simulators for training; commercial CIG activities have emphasized generation of business and television graphics with a small set of vendors using CIG to generate digital special effects imagery for the motion picture industry. The objective of this initiative is to explore adaptation and extension of emerging special-purpose computer image generation systems to the problem of generating high-resolution, high-complexity color perspective images depicting areas of the real world from digital map and collateral data. Desired RGB (red, green, blue) image resolutions range from 1024 x 1024 to 4096 x 4096 pixels/image; desired image complexity can be represented by one million or more projected polygon primitives per image. Anticipated data sources include conventional digital map data from Defense Mapping Agency and USA Engineer Topographic Laboratories which will be augmented by the contractor with additional types of data to represent three-dimensional (3d) structures (i.e. buildings, bridges) and dynamic objects (i.e. vehicles, aircraft) as well as generic patterns and processes to depict terrestrial features (i.e. trees, bushes, water), backgrounds (i.e. sky, clouds) and environmental conditions (i.e. solar illumination, haze, rain, fog, snow, ice, lightning and star fields). The goal of Phase I is to formulate concepts based on use of advanced data structures, rendering processes and cost-effective CIG hardware which could lead to the development of CIG systems capable of generating high complexity terrain images at a rate of at least one image per minute. The goal of Phase II will be to develop a breadboard system for terrain image synthesis with the resolution, scene complexity, data sources and speed cited above. Extensive demonstrations of capabilities will be performed on government furnished data.

A87-244. TITLE: Prediction Model for Verification and Update of MC&G Features

DESCRIPTION: The objective of Phase I is to develop a prediction model concept that can be incorporated into a semi-automated process for verification and update of digital MC&G (Mapping, Charting and Geodesy) data bases. This prediction model would have the capability to make

scene predictions and drive verification and update processors to extract information from a variety of source material using information residing in an MC&G data base. Consideration must be given to various sensor records including Optical, SAR, and IR; existing MC&G data bases and data base structures suitable to a verification and update scenario; and map-guided feature extraction techniques based on knowledge-driven computer approaches. Assume that the task of map-to-image registration has been successfully performed by another processor. The analysis shall determine a suitable data base structure compatible with existing MC&G data bases that is capable of supporting verification and update functions. The analysis shall also determine the feasibility of using computer vision methods and map-guided feature extraction techniques to perform a verification and update on various sensor records. Based on the concepts developed in this phase, Phase II will be directed at finalizing concepts and developing software for the prediction model (mechanism).

A87-245. TITLE: Underground Heat Transfer Algorithms

DESCRIPTION: Currently available energy analysis programs do not have the capability of accurately evaluating the energy requirements of underground structures. Existing algorithms for performing underground heat transfer calculations are too detailed for inclusion in hourly energy analysis programs. The purpose of this research is to develop algorithms which can accurately predict the heat transfer of underground heat transfer surfaces and which are suitable for inclusion in current detailed hourly energy analysis programs such as BLAST. The algorithms would have to utilize readily available input data for the building and surrounding earth temperatures.

A87-246. TITLE: Application of Robotics to Energy Conservation

DESCRIPTION: There is currently a high degree of interest and application of robotic technology in the manufacturing industry. It may be possible to extend the application of this technology to the area of energy conservation. Some types of systems which could be envisioned are robotic inspection of roofs and walls for heat loss. Other possible uses are inspection of energy distruction systems and even robotic meter reading systems. It is not known, however, if these systems are feasible and it is necessary to define the potential for energy conservation, and the technology requirements of these systems. Areas of research interest are robotic navigation with and without beacons, safety aspects of robotic navigation in a community environment, and advanced robotic sensor technology.

A87-247. TITLE: Developing Slurry Fuel from Anthracite Coal

DESCRIPTION: Coal water slurries show significant potential as an innovative near term approach to coal firing in industrial boilers. At the present time, slurry activities have been directed almost exclusively to the use of high volatile, low ash, bituminous coal. A study to evaluate

the potential of anthracite coal as a coal slurry boiler fuel is needed. This study should include the following elements: (1) anthracite coals ability to remain in suspension in a slurry mixture, (2) the ability to atomize and maintain a stable flame when combusting the slurry mixture, (3) supplemental fuel requirements necessary to start and maintain a stable flame and, (4) an economic evaluation concerning anthracite in a slurry as an industrial (5,000 - 80,000 pounds steam per hous) boiler fuel.

A87-248. TITLE: Simplified Joining Techniques for Polymer Composite Structural Shapes

DESCRIPTION: The potential for use of polymer composite materials in constructing space station environments appears to have merit due to the low payload weight involved in moving materials from the Earth. Realization of this potential depends, in part, upon the capability of assembling components into a structure in space. Joints must be simple to make, stable and highly reliable. Techniques used on Earth may not be appropriate or may be highly over designed. Research should address the various materials, joint design, appropriate assembly techniques, potential problems including thermal cycling, stability, reliability and the like.

A87-249. TITLE: Conductive Coatings for Impressed Current Cathodic Protection

DESCRIPTION: Conventional cathodic protection is often not feasible for complex structures and in splash zones. Confined areas and irregular surfaces make proper placement of anodes difficult. Conventional cathodic protection utilizes water as a conductor. The splash zone is not protected because it is not in constant immersion. The splash zone is often the area of maximum coating and substrate degradation for an immersed steel structure. Conductive coatings are available in the commercial market, however, their potential value as the anode for the cathodic protection system has not been evaluated. It is therefore desired that protective coating systems be evaluated to determine the practicality of protecting steel structures by the use of a standard (non-conductive) coating plus a conductive topcoat to act as the anode for a cathodic protection system.

A87-250. TITLE: Internal Pipe Corrosion Management System

DESCRIPTION: Establish quantitative model (which includes establishing equations for relationships between physical parameters) to establish the corrosion management system which will contain the following elements for gas piping, potable water piping, and condensate return piping which will include the following elements:

a. Incorporation of physical parameters into quantitative model.

b. Recordkeeping capabilities of an installation's piping network including location, dimensions and status.

c. Ability to predict the average life o˜ a piping system based on physical and environmental factors.

d. Ability to rank (in descending order) piping systems according to their corrosion status and need of repair.

e. Perform economic analysis comparing alternatives such as replacement or rehabilitation of piping systems.

f. Optimize available maintenance money to determine which piping system should be repaired first to maximize cost savings.

A87-251. TITLE: Potable Water-Pipe Corrosion/Scaling Meter and Water Chemistry Sensor

DESCRIPTION: The objective of this research effort is to identify new sensor technologies for in situ continuous corrosion/scaling monitoring of potable water pipe systems. The monitoring systems will include detection of onset of pitting and changes in water chemistry. The monitoring techniques will have the following minimum requirements:

a. Minimal system perturbation.

b. IR drop effects due to the low conductivity electrolyte need to be properly compensated.

c. The Tafel slopes, Ba and Bc should be obtained from the Rp measurement.

d. Capable of automation.

A87-252. TITLE: Photolysis Rates and Byproduct Formation from Industrial Solvents Discharged from Air Stripping Towers

DESCRIPTION: Industrial solvents such as trichloroethylene (TCE) have been found on numerous occasions in groundwater which serve as potable supplies. A common technology to remove these materials from water is airstriping, however, regulatory agencies are beginning to question the advisibility of transferring these materials to the atmosphere without collection and treatment. Many of these components are light sensitive and are not stable in the atmosphere. The need for alarm at their discharge into the atmosphere would be unfounded if the rates of breakdown in the atmosphere were great enough to keep the concentrations low and limit the migration of a contaminant plume to within property boundaries at the airstripping site. The purpose of this research will be to define the photolysis rate of the more common industrial solvents (tri- and tetra- chloroethylene, methylene chloride, etc.) and to determine the end products of this breakdown. These rates will then be used to predict the potential for air pollution based on the operating characteristics of a water treatment plant.

A87-253. TITLE: Investigation of a Single Indicator as an Index to the Levels of Many Indoor Air Pollutants

DESCRIPTION: To determine if monitoring the level of one gas can reliably indicate the levels of several other pollutants, particularily in indoor training areas. As energy conservation and insulation techniques become better, the concentrations of unwanted gases become higher since there is less infiltration of outside air for dilution. Some activities, e.g. indoor firing ranges, produce a significant amount of noxious gases. The

development of algorithms linking the concentration of these gases to the concentration of another, easily monitored gas would allow the determination of the overall indoor air quality by tracking only a single gas. Of particular interest is analysis of gases in an indoor firing ranges.

A87-254. TITLE: Real-Time Lead Monitor for Indoor Firing Range Personnel

DESCRIPTION: Development of a personal, lightweight lead monitoring device which reflects lead and/or lead oxide dosage levels on an hourly basis. Direct-read-out capability with accuracy to 1 ppm is necessary.

A87-255. TITLE: Creation of As-Built Drawings in CAD Systems

DESCRIPTION: Often during facility and space management activities, one needs as-built drawings (typically a plan view) of existing buildings. Frequently, drawings of floor plans do not exist, are lost or are out of date. To create such drawings people measure rooms, workstations or building components and make pencil sketches that are converted into drawings. This is an expensive, labor intensive and slow process. What is needed is an easy-to-use, portable instrumentation which allows someone to walk through a facility and collect as-built data that can be converted into CAD drawings automatically. The instruments should sense distances and other information, record it, allow for transmittal to CAD software on micro or larger computers and be converted into as-built drawings. The user of the portable instrumentation may need to input additional information which the equipment cannot sense. Software to interface programs is also needed. At minimum, the system should be able to produce line drawings of room and workstations. The capability to produce accurate drawings relating rooms to each other, establish wall thicknesses and locate objects on drawings is also desirable. Direct sensing and automatic drawing creation from data is essential. Skill, knowledge and labor on the part of the system user should be minimized.

A87-256. TITLE: A Physical Process Visualization Technique for Generating Activity Networks

DESCRIPTION: To develop a technique for representing the cognitive mental models that underlie the visualization of a physical process. Much of the Artificial Intelligence (AI) work in plan generation has been based on goal-directed search paradigms which use operations to go from one state to another. The problem with this approach is that the underlying rationale for the action is imbedded in the procedure. For this reason, "look ahead" is tough and often backtracking is required. Furthermore, the domain independence of these approaches for complex spatiotemporal problems is highly questionable. It is hypothesized that a computational model of process visualization could greatly improve plan generation.

A87-257. TITLE: <u>A Knowledge Representation Scheme for Construction Task Formalisms</u>

DESCRIPTION: To design and test a knowledge representation (KRS) scheme for building construction knowledge. The scheme should allow for pattern recognition and the identification of task-formalisms. A task formalism (TF) is an abstract construction task (e.g., "build a 2-door garage"). The next step would be to collect and test a small knowledge base of TFs. This research is motivated by the "action-macro" concept from intelligent-robotics research. They are yet to develop a KRS for test abstractions in domains as complex as building construction.

A87-258. TITLE: <u>A Computer Algorithm for the 3-D Conceptualization of 3-D Building Design Drawings</u>

DESCRIPTION: To develop a computer algorithm for studying a 2-D figure and developing a 3-D (conceptual) representation. A lot of work in machine vision has been done on recognizing objects viewed from arbitrary directions under arbitrary lighting. Results of such research has been encouraging but commercial applications are few and limited. It is hypothesized that, by incorporating design knowledge in a system, one would be able to perform 2-D to 3-D conversion more effectively.

A87-259. TITLE: <u>Identifying Physical Building Components from Graphical Representations</u>

DESCRIPTION: Investigate the feasibility of developing an automated system with the capability of scanning construction drawings and producing a detailed bill of materials. Work should include techniques for using plans and evaluations to create three dimensional images of each building component for the purpose of identifying the type of material and its related quantity. The long range goal is to develop a system to translate construction drawings into material data for cost estimating and for project management.

A87-260. TITLE: <u>Optical Device to Measure Liquid Water Content (LWC) of Clouds and Fogs (Liquid Water Content Meter)</u>

DESCRIPTION: Liquid water content (LWC) of fogs and clouds is a fundamental parameter in studies of cloud physics, acid precipitation, electromagnetic wave propagation and structure icing. The measurement of LWC is extremely difficult. Accurate values of LWC can be obtained from mechanical sampling techniques, however, the frequency of measurement is very low. Impaction techniques such as the hot-wire approach are suited for aircraft operation but achieving collection efficiency using this technique is very difficult. What is needed is a passive optical device, using well-known light scattering properties of water droplets, which could remotely and continuously monitor the changes in the LWC. The ability to differentiate between liquid and frozen state of these droplets would be useful, but any simple reliable LWC indicator would be valuable. The

device should not rely on transmission measurement over an extended path, rather it should be a point measurement device. Since it is a passive optical device it should not have any moving parts and must be able to operate at sub-freezing temperatures.

A87-261. TITLE: Relative Humidity Sensor

DESCRIPTION: A simple, relatively inexpensive device is needed that will make either absolute humidity or relative humidity measurements between 90% and 100% RH and at temperatures from minus forty degree Celsius (-40 C) to zero degrees Celsius (0 C). Accuracy of 1% RH or better is required. This device should be designed so that it can be read electronically by interfacing with standard commercially available data loggers or mini computers. It should be capable of unattended operation in a typical winter field environment. Proposals should include a description of the methodology that the proposor would use to verify the precision and accuracy of any proposed device.

A87-262. TITLE: Graphical Animation for Postprocessing of Computer Program Results

DESCRIPTION: The Corps of Engineers is very active in using numerical systems such as finite elements or finite differences, to model many two-and three-dimensional dynamic phenomenon. These applications include estuaries and coastal hydrodynamics, constituent transport, sediment transport, environmental effects, soil-structure interaction, and structural behavior. Computer programs, such as TABS, HONDO and many others, have been developed and are used regularly in much of the Corps work. Graphical presentations of time-series output have proven to be invaluable in the interpretation of numerical model results. Current capabilities are limited to low-level black and white hardcopy plotting and simple color plots. Animated graphics output is required on both color videotape and film. Proposals should address both software and hardware requirements as well as the use of multi-level distributed computing which includes supercomputers, minicomputers, microcomputers, and a variety of output devices.

A87-263. TITLE: Improvement in Standard Penetration Test (SPT) Apparatus

DESCRIPTION: The SPT is widely used in foundation investigations for military construction of all types. A major shortcoming in the SPT is in the variability of test results caused by differences in operator technique and in design details in the equipment. Current need is for selection or development of a design for a drive system that is suitable for Corps-wide adoption. Requirements are: (1) The system should use a mechanical release mechanism to eliminate operator error; (2) Safety should be at least as good as in currently used "safety hammers"; (3) results should be highly repeatable; (4) Results should be comparable to existing data base; (5) Design would preferably conform to ASTM standard.

A87-264. TITLE: Large-Scale Soils Laboratory Stress Cell

DESCRIPTION: Develop concept for, design and construct a large-scale stress cell and its complement of auxiliary equipment to simulate insitu stress conditions in the soils laboratory environment. The apparatus will be of sufficient size to permit near full-scale or prototype in situ tests, e.g., cone penetration, standard penetration, pressuremeter, dilatometer, borehole shear, stepped blade, vane shear, plate load, pressure cell, etc., in the laboratory. The stress cell will be used for developing interpretative guidelines for in situ soils tests and improving soil sampling and testing techniques.

A87-265. TITLE: Construction of Model Armor Units

DESCRIPTION: Construct scale model armor units of specified size, shape, and density for use in Coastal Model Investigation of Breakwater Stability. Model units are usually made by (1) machining or carving a casting unit of the particular shape desired; (2) making rubber or babit molds; and (3) casting production units by properly selecting and controlling mixtures of materials that will result in a specified density. Density normally desired is 146.25 pcf or a specific gravity of 2.34. Approximately 2000 units each of 3 different sizes of 3 shapes (18,000 units) are initially needed with additional orders dependent on shapes to be investigated.

A87-266. TITLE: Real-Time Satellite Reporting Tide Gage

DESCRIPTION: A need exists for a real-time or near real-time satellite reporting tide gage. The gage should be configured to eliminate the need for surface floats, stilling wells, mechanical clocks, separate atmospheric pressure compensation, and external power. The gage should have switch selectable sampling intervals and sufficient non-volatile internal memory to permit a minimum of one month's data accumulation in the event of up-link transmitter failure. The selected sensor should have long-term stability and linear response characteristics and either require no temperature compensation or, if required, have it contained internally.

A87-267. TITLE: Advanced Sensors for Close Proximity Robotic Mine Detection/Neutralization Platform

DESCRIPTION: A system of sensors integrated with AI microprocessor to detect, recognize and identify precise location of buried land mines. System could include optical, infrared, acoustic, magnetic, RF, microwave, etc., sensors to provide positive detection of mine with minimum phantom signal return. A minimum of three independent sensor types is anticipated for enhanced verification. Signals would be integrated and analyzed by AI microprocessor and verified against pre-programmed mine response signatures. Sensor system would be integral component of advanced robotic platform roving the ground surface in close proximity to the emplaced mines.

A87-268. TITLE: High-Range Dynamic Particle Velocity Gage

DESCRIPTION: High-range ($\geqq$ 300 m/sec) transducer with small physical size, low mass to accurately measure explosively-induced free-field particle motions in earth media. The gage must be able to withstand shock levels on the order of 10,000 g's or greater. The gage must produce continuous data from incidence of motion throughout the entire motion history.

A87-269. TITLE: High Shock Environment Data Acquisition and Storage Module (100 kg)

DESCRIPTION: Develop a high-speed, compact, rugged, signal-channel data acquisition system capable of withstanding 100,000g shock waves (NOTE: An interim capability of 5,000g's would also be acceptable). The system should be as small as possible (typically 3-1/2 in. maximum dimension). It should require no external wiring (completely self contained). It should collect analog data from an integral sensor at selectable stable rates (possibly as high as 4 megahertz) and store it in internal memory of 1 megaword (where each word is 16 bit). The data should consist of 12 bits of A/D data, a synchronization bit, and 3 dynamic gain bits (i.e., floating point A/D converter). The sampling should have several modes of trigger activation (such as continuous sampling until trigger, then fill 3/4 more of memory and stop). Triggering should be selectable from communicated signal or threshold level of analog input. There could be a radio link (or some other nonphysical path) with the "can" for communication. Communication should be coded so as to prevent false interpretation of noise, should allow retrieval of information while the can is still buried under the earth and should allow reset and trigger signals to be input to the can. The can should have internal batteries capable of operating the circuitry for at least two weeks standby (1 day active) with remote activation.

A87-270. TITLE: Development of Portable Direction Indicator for Hydraulic Data Collection

DESCRIPTION: The over-the-side equipment used to obtain discrete samples from a boat consists of a current meter, direction indicator, and weight, all suspended by a wire rope, plus remote readout devices and support frame. The assembly is mounted on a boat that moves from station to station collecting data. The current meter is vertical-axis, cup-type meter (Gurly Model 665) with remote, direct-reading speed indicator. The present direction indicator consists of a remote-reading magnesyn compass mounted just above the current meter in a waterproof cylindrical housing. Suspended below the meter is a finned, streamlined weight (fish) that holds the sensors in a vertical attitude facing into the flow. The sensor assembly is supported by a 1/8-in. wire rope from a portable support frame that is equipped with a winch to raise and lower the assembly. An indicator on the winch shows the sensor's depth below the water's surface.

An inexpensive, lightweight portable direction indicator for use with WES

current meters for "over-the-side" prototype data collection surveys needs to be developed to replace unit mentioned above. The unit should be for use in freshwater/saltwater environment, very durable, and easy to mount on steel cable suspended over the side of boats. Current directions need to be read on board by digital readout or equivalent.

A87-271. TITLE: Rugged, Light Weight Field Dental Chair

DESCRIPTION: There is a need for a light-weight, low-cube field dental chair for patients. Requirements of the new chair are: Weigh less than ten pounds; allow stand-up and sit-down dentistry; be rugged; be easily cleanable; and fold to a small volume.

A87-272. TITLE: Nonmetal Dental Instruments

DESCRIPTION: A need exists to develop nonmetal instruments that can withstand repeated sterilization. These instruments should be light weight, durable, and maintain edge strength.

A87-273. TITLE: Electromagnetic Pulse (EMP) Hardening of Medical ISO-Shelters

DESCRIPTION: Military field hospitals use a line of expandable iso-shelters (managed by Natick Research and Development Center) for various purposes. These shelters are made of aluminum and intrinsically offer about 10 db of shielding to electronic devices inside. There is a need to develop a retrofit kit that will increase the shielding offered by these shelters up to the 20 dB level. The retrofit should require minimal upkeep throughout the life of the shelter and must not significantly increase the set-up or take down time of the shelter, or reduce its utility when it is in use.

A87-274. TITLE: Diagnostic Test Strip for Salivary Cholinesterase

DESCRIPTION: There is a need to develop a test strip that can measure cholinesterase levels in small amounts (20-200 microliters) of saliva. The test strip should work in less than five minutes and differentiate between the following levels: Less than 0.25 units/liter; 0.25-0.5 units/liter; 0.50-1.0 units/liter; 1.0-1.5 units/liter 1.5-2.0 units/liter; and greater than 2.0 units/liter. (One unit of acetylcholinesterase activity = one micromole of acetylcholine hydrolyzed/minute).

A87-275. TITLE: Improved Wound Dressing Material

DESCRIPTION: A need exists for new wound dressing materials that will simultaneously protect wounds from the outside environment (i.e., noxious agents as in chemical warfare), enhance healing and combat infection. The material should be comfortable, conformable to body topography, and should adhere well to the intact skin to form an imperable seal. A minumum five-year shelf life is desirable.

A87-276. TITLE: Small, Light-Weight Dental Sterilizer

DESCRIPTION: A small (less than one cubic foot), light weight (less than 15 pounds), low power autoclave is needed for field use. The autoclave must be able to operate from 28 VDC or 120 VAC power sources. The method of sterilization should require no, or only small amounts, of water or other chemicals. Present cold sterilization of instruments requires large volumes of chemical and longer sterilization times.

A87-277. TITLE: Self Development Dental X-Ray Film

DESCRIPTION: Current field dental films require standard dental processing techniques. Because of this, a large bulk of chemicals and a daylight developing machine must be transported by field dental units. Development of self-developing dental x-ray films would greatly reduce the logistical demands on current field dental units. Self-developing dental x-ray films should have the following characteristics: Be completely compatible with current dental x-ray machines; come in periapical, bitewing, and occlusal film size; and exhibit long shelf life. The film speed should be comparable to modern "E-speed" films.

A87-278. TITLE: Pattern Recognition of Digital Radiographic Images

DESCRIPTION: Use of artificial intelligence techniques to identify discontinuities in digital radiographic images could assist the physician in interpreting radiographs in the field. A thorough literature search and feasibility assessment, performed as a SBIR effort, would be a logical first step toward developing such a system.

A87-279. TITLE: Characterizing Soldier Response to Irritant Gases (Basic Research)

DESCRIPTION: Irritant gases (HCL, NH_3, Formaldehyde, etc.) associated with weapon systems exhaust emissions are known to produce performance decrements under certain circumstances. Human response to an irritation threshold is complicated principally by the duration of the exposure at a given concentration, intermittency of the exposure, acclimation, and the definition of a performance decrement. The proposal should address the feasibility of defining through animal and human testing a military-unique task potentially affected by the irritant properties of at least three gases, establishing a concentration-time relationship, if appropriate, and evaluating the role of acclimation, annoyance tolerance, and intermittency on the selected task.

A87-280. TITLE: Antidotes and Pretreatments Against Radiation and Chemical Warfare Agents

DESCRIPTION: There is a need for drugs which are useful as protectants against ionizing radiation from nuclear weapons. There is also a need for treatment of prophylactic drugs against the threat of chemical warface agents. These chemical agents are: organophosphate nerve agents; cyanides

or vesicants. Synthesis of such potential drugs requires basic understanding of drug development in addition to strong background in organic synthesis. A strong biological/biochemical rationale is needed to support any synthesis proposal in this area. Three to five gram quantity will be required for accomplishment of biological testing by the MRDC. Structural classes other than those containing oximes and/or phosphorothioates should be explored.

A87-281. TITLE: Workload Prediction and Evaluation Techniques for Health Hazard Assessment

DESCRIPTION: A requirement exists to determine which workload prediction and evaluation techniques are most appropriate for use in three phases of the Army Materiel Acquisition Decision Process (MADP) in which Health Hazard Assessments must be performed. The objective is to identify which workload prediction and evaluation techniques have been developed and are best suited for use in the evaluation of crew workload in a system during the concept exploration, demonstration and validation, and full scale development phases of the MADP. The techniques considered to be most appropriate for each phase (e.g. Projective Subjective Workload Index (W/IND) for the concept exploration phase) are to be compared and evaluated with the strengths and weaknesses of each technique identified.

A87-282. TITLE: Blood Substitute

DESCRIPTION: A requirement exists for a safe, efficacious emergency blood substitute for human use when whole blood is unavailable. Any proposed substitute should provide acceptable volume expansion as well as tissue oxygenation delivery capacity without requiring oxygen-enriched breathing mixtures. Prolonged room temperature storage of the dehydrated material is desirable for logistic purposes.

A87-283. TITLE: Blood Preservatives

DESCRIPTION: A requirement exists to develop a new blood preservative that allows red cells to be stored at ambient temperatures for 5-7 days while maintaining at least 80 percent of their original 2,3 diphosphoglycerate.

A87-284. TITLE: Physiologic Stabilization after Trauma

DESCRIPTION: A general requirement exists to provide improved field care after traumatic injury when evacuation is delayed. The overall aim of this research and development is to provide treatment under adverse conditions that maximize salvageability and recovery once definite care becomes available. Contemplated efforts cover a wide technological spectrum from state-of-the-art applications designed to improve and simplify first aid and resuscitative methods on the field to basic scientific investigations designed to explore unusual and innovative technical means for temporarily suspending or stabilizing pathophysiologic processes after traumatic injury.

A87-285. TITLE: Improved Production of Artemisinin by Artemisia Annua Under Experimental Conditions

DESCRIPTION: The anti malarial drug artemisinin (quighaosu) is obtained in very low yield from the leaves of the plant Artemesia Annua. Investigation is required for the modification of the growing conditions of the plant by techniques such as cell culture, hydroponics and through the use of soil additives which could result in the development of higher yielding plants for the more economic production of the drug.

A87-286. TITLE: Research in Simulator/Device Mix Methodologies

DESCRIPTION: As technology expands in the area of simulation for training, the Army must determine the most effective and least costly methods of mixing devices to support training in operational units. A methodology for clustering critical tasks and sequencing the skill acquisition process across part and full task trainers would be extremely useful. Techniques are needed for examining existing and proposed simulators for their unique "niche" in the overall unit training program.

A87-287. TITLE: Optimal Presentation Strategies for Computer Based Instruction

DESCRIPTION: The combination of optimal control theory, quantitative models of learning and memory, and computer based instruction remains a promising approach to the use of technology in instruction. However, early work to develop optimal instruction based on the one-element model, the incremental model, and the random-trial increments model has not been pursued despite recent development of improved techniques for parameter estimation and more powerful models of learning and memory. We need to devise optimal approaches to instruction that capitalize on these recent developments. These approaches should be demonstrated to be either locally or (preferably) globally optimal using formal means and to be genuinely powerful instructional techniques using empirical means.

A87-288. TITLE: Developing the Concepts for a Comprehensive Suite of Human Component Models Applicable for use with Meaningful Categories of Soldiers

DESCRIPTION: Computer modeling should be helpful in predicting soldier and manned system performance. However, for such models to have the most utility, they should be driven by objectively developed data rather than the opinions of experts. The purpose of this effort is to analyze human characteristics into a suite of component characteristic clusters that would, taken together, be a total model of human performance. Existing modeling and data universes need to be identified. The possibility of acquiring the data required to create new models needs to be assessed and

appropriate new model development undertaken. Component models should be applicable for use with existing meaningful categorizations of Army soldiers.

A87-289. TITLE: Methods for Assessing Human Performance in Large, Complex Organizations

DESCRIPTION: Large, complex organizations, such as military combat units at the Corps level and above, involve the interaction of a multitude of physical, organizational and psychological variables. Here, a great number of systems, goals, resource constraints, cultures and processes interact to confound the influence of individual components on overall organizational performance. As a result, it is often difficult to project the real-world impact of specific combat development initiatives on combat unit effectiveness.

Improved methods are needed for characterizing and assessing the influence of specific physical, organizational and psychological variables on the combat effectiveness of large, complex military units. Such methods, at a minimum, should provide the necessary theoretical framework and practical tools for identifying significant interactions among these variables and for predicting the impact of changes in these variables on combat unit effectiveness.

A87-290. TITLE: Measurement and Models of Employment Decision Making

DESCRIPTION: Each year the Army must enlist and reenlist thousands of soldiers. In order to recruit and retain high performing soldiers, it is important to be able to understand, measure, and model the variables considered by individuals in making their decisions to join the Army or reenlist. These variables are also important in terms of the decision to enroll and continue in ROTC and to make a career as an officer in the Army.

A87-291. TITLE: Research in Artificial Intelligence for Non-Communication Electronic Warfare Systems

DESCRIPTION: In the Non-Communication EW Mission, there are several application areas that appear as likely candidates for the use of Artificial Intelligence (AI) techniques. Some of these include: ELINT System Management, Jammer Power Management, Threat Warning, Management of Unmanned Systems, Simulation, Maintenance, Training and Management of Integrated Aircraft Survivability Equipment (ASE). In each of these areas, there is a significant need for human expertise in terms of background, experience, and judgement. The primary goal in the application of AI techniques to EW systems is to capture the knowledge of experts and replicate it for use by non-experts. An extension of this goal is to replace the human operator, especially when logistic or hazardous considerations make replacement appropriate.

A87-292. TITLE: Integrated Aircraft Survivability Equipment Effectivity Model

DESCRIPTION: Develop a computer simulation program to evaluate the effectiveness of both on-board and off-board aircraft survivability equipment (ASE). The data base should include generic radar/IR threats and existing ASE responses. Inputs should include a variation of the data base as well as new countermeasures (CM). The timing and sequence of the ASE should be variable. The effectiveness of the ASE should be measured in threat break-lock or missile miss distance. The program should be compatible with a VAX 11/730 Computer.

A87-293. TITLE: Aircraft Multi-Spectral Radio Frequency/Electro-Optical/ Infrared Countermeasurers

DESCRIPTION: Analysis needs to be performed to determine how to counter weapon systems that have integrated RF/EO/IR target acquisition and tracking systems. Successful jamming of these systems may require integrated Multi-Spectral Countermeasurers.

A87-294. TITLE: Advanced Infrared (IR) Source

DESCRIPTION: Infrared Countermeasurers (IRCM) require the efficient generation of radiation in the 3-5 micron and 8-12 micron spectral region in order to develop compact, lightweight systems. The proposed task will explore novel materials/devices for eventual application to IRCM systems.

A87-295. TITLE: Energy-Compensated Detector and Front End Electronics for Radiacmeter

DESCRIPTION: Solid-state (e.g. Silicon) detectors show promise of suitability for nuclear radiation survey meter applications, particularly with regard to small size and modest power demand. In the pulse counting mode of operation, however, their response is rather non-uniform, when exposed to equal dose-rates of radiation at various quantum energies. Energy compensating shielding and/or electronic techniques for charge averaging are required to ensure more uniform energy response, suitable for a compact, low-power/cost radiacmeter.

A87-296. TITLE: Research on Radiochromic Leuko Dye Solutions

DESCRIPTION: Radiochromic Leuko dye solutions make an excellent core material for Radio-Chromic Optical Waveguide Dosimeters. An occasional problem is that some batches of the mix turn yellow with time without exposure to nuclear radiation. It is thought that the problem may be due to contaminants in the synthesis of the dye or peroxides in the components of the mix. Research to discover and eliminate the contaminants or peroxides is needed or at least to discover a stablizer.

A87-297. TITLE: Eagle Scanner for a Radar Cuer

DESCRIPTION: Phase I (approx. $50K) would provide for the design of an undirectional electronic scanning antenna for a microwave radar. Phase II (approx. $250K) would provide for the fabrication and demonstration of the antenna. The radar would be designed within EW/RSTA and the Eagle scanner antenna would be integrated within the system, whose application would be to detect targets out to 5 km and cue an existing EW system to a selected target. The Eagle scanner is an effective lower cost alternative to the more conventional individual phase shifter-per radiating element design. This project could be done by a small business antenna facility and completed within 18 months.

A87-298. TITLE: MET Balloon Improvements

DESCRIPTION: Meteorological (MET) Balloons currently in production suffer from reliability and shelf-life problems, and offer reduced performance (e.g., rate-of-ascent) relative to balloons manufactured years ago. The principal factor that induced this degradation is the fact that about 5 years ago, Government safety agencies (EPA and OSHA) removed a number of hazardous chemicals from potential use, resulting in cutting off the supply of some key chemicals that had previously been used in the manufacture of MET balloons. The purpose of this task is to investigate possible areas for improving balloon manufacturing processes and materials, with the objective of increasing MET balloon reliability and performance, and decreasing unit cost. Even a small improvement in reliability would yield a large cost savings because: (1) the Army uses a large number of MET balloons each year; and (2) the MET radiosondes carried aloft by these balloons, which are far more expensive than the balloons themselves, would enjoy a greater utilization factor.

A87-299. TITLE: Reusable Software

DESCRIPTION: As the demand for complex software increases, new technologies are being investigated to reduce the development and maintenance costs. Software reusability is one such technology which can provide a significant cost reduction in both areas. Research is needed in the areas of domain analyses, methodologies, environments and libraries. The objectives include, the development and testing of prototype methodologies and tool sets for the development of reusable software modules as well as classification schemes, retrieval techniques and tools for the operation of a reusable software library.

A87-300. TITLE: Artificial Intelligence for Command and Control

DESCRIPTION: The tactics and doctrine of the modern battlefield dictate the need for intelligent machines to assist human operators. The technology associated with encapsulating knowledge and techniques used in AI to capture the reasoning process that human experts perform promises to provide a significant impact on future computer system for the military.

Future military systems will be required to be self-learning and interactive. Self learning systems are systems that are able to make significant changes in their internal processing logic in response to user commands or based on demands which have been placed on the system in the past. These systems are extremely important in the military environment because they create significant operational capabilitites across a diverse set of applications. They are fundamentally superior and inherently more reliable than the conventional rigid systems because they can be made more fault tolerant and possibly can be given limited properties of self-diagnosis and self repair.

In addition to self-adapting systems, the following AI technology Advances are required to insure the adequacy of future military systems:

(1) improved man/machine interfaces
(2) the ability to represent and reason with data that is imprecise, incomplete, not totally reliable, and varying in time.
(3) improved methods for knowledge acquisition
(4) Database access strategies to include Database Management services for expert AI Systems
(5) methods for maintaining/enhancing expert systems once they are fielded out.

A87-301. TITLE: <u>EM Propagation in Un-Ionized Media - State of the Art Assessment</u>

DESCRIPTION: The Army 21 concept as related to real time battlefield communications has underscored the need for reliability, insured connectivity and enhanced survivability of strategic, operational and tactical reciprocal communications modes (links) among national command authority, theater commanders and the battlefield arena. Electromagnetic propagation in an adverse electronic environment is an integral part of the communication network, and it impacts directly on these needs. In particular, the following specific EM propagation considerations are of interest:

(1) Propagation media characteristics (ground, troposphere)
(2) Techniques for assessment of media state
(3) Attenuation and scattering by precipitation and other atmospheric particulates on microwave/mm waves.
(4) Propagation in vegetated environment
(5) Propagation in urban/suburban environment
(6) Atmospheric interface characteristics (near ground, near water, reflection, refraction, ducting)
(7) Natural/man made propagation media modification
(8) Diffraction and shadowing effects
(9) Propagation aspects of digital signals across the electromagnetic spectrum (multipath, fading, etc)

(10) Radio noise (natural, man made and intentional)
(11) Propagation aspects of satellite/earth communication (especially atmospheric & ground effects at low elevations)
(12) Scatter communications
(13) Optical propagation (guided and unguided)

The objective of the task is to perform state-of-the-art assessment of the above subjects with a view towards the relation of these to the Army's goal of real time, reliable, continuous and survivable communications goal. Gaps of knowledge in these fields which need addressing to meet the Army's requirements should be identified.

A87-302. TITLE: Advanced Facilities to Expedite Design and Evaluation of Communications Systems

DESCRIPTION: Facilities are needed which will significantly reduce the time and cost to design, test, and evaluate Army Communications systems. These facilities must provide the ability to quickly create realistic test cases to predict and evaluate system performance in a way that could be easily understood by combat developers as well as communications engineers. The dynamics of the battlefield must be easy to represent in an accurate manner, including air and ground vehicle motion, propagation effect in densely foliated and rough terrain based on Defense Mapping Agency data, threat systems and strategy, and user communications traffic needs. Communications systems must be easy to represent to the degree of accuracy desired, including adaptive antennas, wire and glass cable, signal processors using various spread spectrum techniques, messages and voice processors, virtual circuit and packet switches, concentrators, network controllers/managers, etc. The ease with which these items can be represented and modified for quick reaction use, and shared by many organizations is paramount.

A87-303. TITLE: Software Product Assurance Cost Estimating Model

DESCRIPTION: Experience has shown that DOD must independently monitor software development/maintenance performed by contractor or government personnel in order to insure a reliable and maintainable system. However, estimating the resources required for a thorough software quality assurance and independent verification and validation effort is a difficult task. Estimating models exist which predict total product cost, schedule and personnel requirements but no known tool adequately addresses external product assurance resource estimate.

The goal of this solicitation is to develop and demonstrate the "real world" accuracy of a computerized model that predicts resource requirements for independent external product assurance coverage. The model must maximize the use of input and/or output parameters used in the DODs currently accepted version of total project software cost estimating model (i.e., SECOMO). This will eliminate redundant efforts in generating inputs or duplicating calculations.

A87-304. TITLE: Automated Tools for the Analysis of Real-Time Multiprocessor Software Design

DESCRIPTION: In order to assure that military Real-Time multiprocessor software is reliable, maintainable, testable, portable and efficient, standard practice requires a development contractor to perform a top-level and detailed design prior to code implementation. This design effort is basically defined as the allocation of requirements to a hierarchial structure of modules and the specification of intermodular data flow.

The analysis of the documented design by an independent monitoring agency is a subjective and skill/manpower intensive effort. The objective of this solicitation is to adapt exisiting techniques and develop new techniques which result in a more objective and automated methodology for analysis of real-time multiprocessor software design. The design evaluation variables would include software engineering principles such as cohesion, coupling, complexity, metrics for modules and subsystems, scope of effect/control and information hiding. The tool should facilitate appropriate analyses for different design methodologies and stages or levels of design. The goal of the automated methodology is to identify design problem areas such as poor structure and modularity or inefficient allocation of functions to processors. The prototype tool would be applied to an actual military project to assess the feasibility of its widespread use.

A87-305. TITLE: Parametric Analysis of MAP Data

DESCRIPTION: Future weapons systems are expected to employ DMA map data to enhance their performance. Map data may be useful for an aid in scene feature recognition as well as autonomous navigation. An analysis should be made relating the information content in a multiple frame "Panarama" FLIR image with map information and various degrees of assumed apriori knowledge. The degree to which a correlation can be made between map data and a sensed image should be determined for combinations of the following:

.Accuracy of known sensor parameters location, look angle, altitude, resolution
.Degree of map resolution
.Amount of map variations (i.e., number of changes and rate of change of altitude information).

This should be determined first of all for map elevation data only. Secondly, an analysis should be made as to the added usefulness of map cultural features. Although mostly a theoretical study, considerations should be made as to testing procedures with actual FLIR imagery.

A87-306. TITLE: Non-Destructive Testing of Infrared Materials, Diodes

DESCRIPTION: Development of non-destructive, non-contact techniques for evaluating the important materials parameters of infrared semiconductors used for infrared photodiode detectors. The measurements should directly

relate to the ultimate diode performance and allow prediction of its properties, sensitivity, noise characteristics, responsivity at different wavelength and electrical characteristics. The methods should be applicable to cadmium mercury telluride sensitive to 12 microns radiation.

A87-307. TITLE: Automated Minimum Resolvable Delta Temperature (MRT) Test Development

DESCRIPTION: The work shall involve an analysis of a hypothetical time series of video frames of a 4-bar, 7:1 aspect ratio target to arrive at a relationship between observer probabilites of target detection and recognition and the amplitude and frequency content of the video input electrical signals and noise.

A87-308. TITLE: Integrated Multi-Wavelength Band Calibrated Digital FLIR

DESCRIPTION: Explore recent advances in IR Technology to design and perform critical experiments for radiometric simultaneous 3-5 and 9-12 micron measurements of target signatures.

A87-309. TITLE: New MOVPE-Grown FIR Detector Materials

DESCRIPTION: Fabrication of new FIR detector materials via organo-metallic vapor phase epitaxy (MOVPE), for use in the 8-14 micron spectral range. Low temperature techniques will be emphasized in these processes to off-set interface diffusion problems.

A87-310. TITLE: Epitaxial IR Materials Technology for High Performance 2nd Generation Systems

DESCRIPTION: To improve the HgCdTe epitaxial growth techniques and related substrate (CdZnTe) growth method and processing. The research must systematically attack the unknowns in the HgCdTe epitaxial growth techniques and the nature of the defects in HgCdTe and their methods of formation; their ionization energies when they act as defect dopants; and how best to grow and process detectors where the adverse effects of material defects are minimized. Moreover, to ultimately tailor both the HgCdTe epitaxial growth method and the CdZnTe substrate growth method to the appropriate quality for high performance IR detectors.

A87-311. TITLE: Long Wavelength Infrared Detector Arrays

DESCRIPTION: Large (greater than 5000 element) infrared detector arrays, sensitive to radiation in the 3-14 micrometer spectral region, are required for second generation FLIR target acquisition sensors. Device fabrication concepts include heterojunction diodes, homojunction diodes, metal insulator semi-conductor devices, charge injection devices, or Schotky barrier detectors. Background limited device operation, uniformity of response, and a low noise power spectral density are salient operational requirements of the array. Fabrication processes, which minimize damage to

the material and provide a high yield in production, are necessary to reduce array cost and to produce arrays in the desired quantities. Non-destructive in-process test methods to evaluate detector quality at interim process steps are important features of array fabrication.

A87-312. TITLE: Tunable Solid State Laser Source

DESCRIPTION: Laser sources, which are tunable or can be produced to generate various wavelengths in the visible (400 nm to 700 nm), are needed for various applications. These sources must be solid state or semiconductor, efficient, reliable, and compact and capable of producing high peak powers in pulsed operation. Possible sources are solid optical materials pumped by flashlamps or laser diode arrays; bulk semiconductors electrically excited by tunneling or avalanche processes, or efficient frequency up-conversion techniques combined with currently available lasers.

A87-313. TITLE: Infrared to Visible Upconversion

DESCRIPTION: Material research is sought to provide improved response, operational bandwidth, quantum efficiency, sensitivity (both magnitude and wavelength range) for the upconversion of infrared radiation to visible. Phosphors and photo-luminescent materials which can detect and display infrared radiation in reflective and transmittive modes are desired. Possible applications include the writing of information with laser diodes and displaying it in the visible for reading, and for detection of incident infrared laser radiation.

A87-314. TITLE: MID Infrared Laser

DESCRIPTION: Development of efficient methods for generation of both pulsed and continuous output laser radiation in the 3.8 to 4.2 micron spectral band. Electrical to optical output efficiency of over one percent is desired.

A87-315. TITLE: Laser Diode Array Fabrication

DESCRIPTION: The Army needs gallium aluminum arsenide laser diode arrays to pump solid state lasers such as Nd-YAG for high efficiency laser systems. Currently, these high power arrays are expensive with a cost of $100.00 per watt of output in long pulse operation. A program to reduce the cost of producing these arrays including MOCVD growth, wafer processing, linear array bonding, and linear array testing is required. Individual contractors could address one or all of these processes to reduce costs.

A87-316. TITLE: Broadband Emitting Cathode Ray Tube

DESCRIPTION: Developmental work to produce a television cathode ray tube that will provide broadband emissions between .4 and 12 microns including

appropriate electronics that will allow RS-170 and RS343, 875 line video inputs. This device must produce broadband television rate imagery without artifacts caused by thermal lag (decay time).

A87-317. TITLE: Helicopter Night Pilotage System

DESCRIPTION: A concept and demonstration is needed of a wide angle (45 degrees vertical by 90 degrees horizontal) pilotage system which is fixed in the helicopter frame of reference. An 8 to 12 micron FLIR views the area forward of the aircraft and displays the image to pilot via a projection/display system in the cockpit. The infrared sensor should use standard components such as bobbin scanner (normally used in line scanners), Common Module detector, imager and cooler. Critical issues are display design and integration to sensor and aircraft.

A87-318. TITLE: Sharing Tactical Knowledge Across Brittle Expert System Domains

DESCRIPTION: Background: The recent flurry of expert system development has reached the point of diminishing returns, where a moderate increase in performance requires an incommensurate level of effort. Part of the problem stems from the so-called "brittleness" of an expert system, or a lack of real world knowledge beyond its constrained, narrow domain of expertise. There is hope, however. Suppose for a moment that two brittle expert systems were to be interfaced with a tool which understands how the two might be related in the context of some larger system. Of course the two expert systems must possess some degree of commonality; for example it would make little sense to conjoin Prospector and Mycin because mineral exploration and infectious disease diagnosis and convincingly different domains. Fortunately, battlefield functional activities don't have that problem: they depend upon one another.

Assume the existence of a token-passing ringing of 12 battlefield expert systems, which are willing to share knowledge across their boundaries, but have not yet been implemented to do so. There are 66 (12 objects taken 2 at a time) possible interfaces among the dozen expert systems when pairwise compared. This number at first glance seems prohibitive, but it compensated by the generally smaller size of the required interface versus the sized of the two individual expert systems being conjoined. Currently, lexicons and closed-world natural language parsers have been designed and implemented for the following set of functions: infantry, armor, artillery, air defense, engineers, logistics, signals, radio electronic combat, reconnaissance, aviation, and chemical-biological-radiological types of activity.

Task: Conceptualize, design, and implement the 66 pairwise interfaces among the 12 battlefield functional expert systems. As an example, consider the interface between aviation and engineers. Engineers might clear an airstrip for aircraft during maneuvers; aviation might provide air

cover for engineers during a fire fight. The aviation-engineers interface would need to contain this kind of knowledge.

Bidders must possess tactical battlefield expertise (the government does not have the resources to train anyone); have unlimited access to their own dialect of Lisp (preferably Interlisp, otherwise Common Lisp, Zetalisp, or Franz Lisp); have their own computing facility (due to other commitments, the government cannot provide a computer); have a demonstrable track record in innovative artificial intelligence research focused on natural language; document a talent for not only developing new concepts but also implementing them in Lisp software just short of the advanced development level.

Desired deliverables include a final scientific/technical report, quarterly progress reports (containing entries which describe objective, approach, and progress), Lisp source code, software installation manual, user's guide, and documentation.

A87-319. TITLE: Cooperating Distributed Expert Systems

DESCRIPTION: Category: Exploratory Development Independently functioning expert systems are now beginning to find their way to be analyst/operator workstations. Tomorrow's systems will require that these independent expert systems to "Know" how to cooperate with other independent expert systems in a synergistically beneficial manner. To accomplish this, issues of "Knowing of Others", "Knowledge Master", "Knowing the Limits of Knowledge", common knowledge access, and conduct of expert system transactions, among others, need to be investigated and documented. This effort seeks to define how small independent expert systems with distributed knowledge and functionality need to be constructed in order to cooperate and interact with each other. This effort will require research into fundamental Expert System constructs, tools, and overall architecture to define a prototype of such an expert system. This effort will then require an implementation of a prototype networked system to be built as a proof of principle. The IBM-PC family of computers using Common Lisp/Prolog will be required vehicles for the prototype system development. This configuration closely embodies the characteristics expected in the first generation of personal expert system analyst/operator workstations that will be fielded.

A87-320. TITLE: Integrated Power Circuits

DESCRIPTION: Jammer amplifier and transmitter circuits need to be lighter and cheaper. Integrated circuit technology has made low power analog and digital circuits extremely cheap. It is desired to perform similar integration on power circuits, handling 100-400 W output power per basic power module. These power modules would be in the HF and VHF bands, e.g. 1-100 MHz, 80-400 MHz. The basic power modules would be used alone or in assemblies to make up a large transmitter. The use of integrated circuit concepts should increase reliability and decrease costs. The circuits

substrate could be used for a cooling surface and the circuit could be designed mechanically to have modular, self aligning cooling passages for liquid or air cooling when assembled in large transmitters.

A87-321. TITLE: Automated Collection Management

DESCRIPTION: During a tactical engagement the collection manager is responsible for the development of an intelligence sensor collection plan, called a collection plan, which when enacted will potentially develop the necessary intelligence for the commander by managing the use of the intelligence sensors currently available to him. This management process nominally considers a variety of factors to include target nomination and threat, a knowledge of the target operating characteristics, sensor nomination and expected accuracy, sensor vulnerability, possible effects of weather and terrain, and the type/types of intelligence information sought. In addition, the collection manager will frequently attempt to merge two or more differing collection plans into a single collection plan which will potentially satisfy all of the intelligence requirements more efficiently.

Historically, those paradigms which have been developed to automate this collection management process have been inadequate primarily due to two design deficiencies. First, they have been overly simplistic. They make a series of simplifying assumptions which make the paradigm tractable but result in an uninteresting and insensitive analysis process which is generally considered inaccurate and not usable. Second, they make complex modeling assumptions which are only relevant and factual for a unique set of battlefield conditions. This type of approach (usually an artificial intelligence expert system approach) results in an algorithm which is domain-sensitive and not effective within other dissimilar tactical domains.

Due to the complexity of this collection management problem, recommend that the selected offeror prepare a scientific and technical report which should contain the following two sections. First, a thorough and scholarly review and discussion should be made of the available algorithms which could possibly be used to automate the collection management process as described. This section should contain a comprehensive bibliography and references and should demonstrate concise, logical thought and reasoning. The second section of this document should contain a persuasive description of innovative research performed by the offeror and his solution to the collection management problem. Again, this discussion must be thoroughly supported in an academic manner and must convincingly demonstrate and support the algorithm's theoretical innovation, while possessing none of the critical weaknesses of those algorithms discussed in the first section of this document.

A87-322. TITLE: Expert System Design/Redesign Capability

Today's expert systems are being individually tailored to accomplish a specific domain task. These systems do not allow for or accommodate

orderly redesign as a result of change or growth from learning. Additionally, these systems do not allow for a user to tailor a generic package of a specific domain requisite expert functionalities/tools to design an expert system fitted to his requirements in that domain. Tomorrow's system must be constructed in a manner to allow them to be dynamic in nature. The software maintenance costs of modification/ tailoring individually specific expert systems will be too great to make them feasible on a large scale. The knowledge of how to build/modify an expert system for a specific domain learned during development must be incorporated into the systems of tomorrow. This knowledge which was learned by the original knowledge engineer must be encapsulated and passed forward and not be lost in the sands of time. This effort will require research into expert system modular structuring constructs, learning from user interrogation, conceptual system modeling, and other related topics. The results of these investigations need to be documented and to define a prototype of a system concept. A small bounded implementation of the prototype system will be required for proof of principle. The IBM-PC family of computers using common Lisp/Prolog will be the required vehicles for the prototype system development. This configuration closely embodies the characteristics expected in the first generation of personel expert analyst/operator workstations.

A87-323. TITLE: Analytic Support for Fire Support (Artillery) Robotics

DESCRIPTION: Perform analysis of the potential for the force multiplication, risk reduction (to friendly troops) and/or operation and support cost reduction through tactical employment of telerobotic fire support robotic systems for artillery. Analysis should assess opportunities to employ these systems in the current force structure through projected force structure through 2010 and should address, as a minimum, requirements for:

- Weapons system characteristics
- Platform mobility (if a mobile system)
- Level of system autonomy specifically addressing fire control
- Approaches to system command and control (including data links)
- New tactical employment options
- System expendability trades
- Sensor system and processing requirements

A87-324. TITLE: Analysis for Combat Support Robotics

DESCRIPTION: Perform analysis of the potential for the force multiplication, risk reduction (to friendly troops) and/or operation and support cost reduction through tactical employment of telerobotic and robotic manipulator systems for combat support. Analysis should assess opportunities to employ these systems in the current force structure through projected force structure through 2010 and should support, as a

minimum, requirements for:

- Obstacle and minefield breaching
- Bridging
- Platform characteristics
- Manipulator characteristics (if any)
- System expendability trades
- Command and control approaches (include data links issues)
- Sensor system and processing requirements
- Utilization in conjunction with unmanned aerial vehicles

for applications such as mine detection

A87-325. TITLE: Analytic Support for Combat Service Support Robotics

DESCRIPTION: Perform analysis of the potential for the force multiplication, risk reduction (to friendly troops) and/or operation and support cost reduction through tactical employment of telerobotic and robotic manipulator systems for combat service support. Analysis should assess opportunities to employ these systems in the current force structure through projected force structure through 2010 and should support, as a minimum, requirements for:

- Explosive ordnance disposal
- Tactical logistics
- System through put requirements
- Platform characteristics
- Manipulator characteristics (if any)
- System expendability trades
- Command and control approaches (include data links issues)
- Sensor system and processing requirements
- Utilization in conjunction with unmanned aerial vehicles

for applications such as mine detection

A87-326. TITLE: Demonstration of High Lift to Drag Ratio Parafoils

DESCRIPTION: Demonstrate remotely controlled parafoil unpowered flight at a system required L/D ratio greater than six for at least 30 continuous seconds of each of three flights, with automatic soft landing of 500 pound rectangular rigid payload streamlined by inflated fabric and provide drawings and fabrication specifications sufficient to enable the Army to duplicate units and repeat test results.

A87-327. TITLE: Demonstration of High Lift to Drag Ratio Rogolo Wing

DESCRIPTION: Demonstrate remotely controlled rogolo wing unpowered flight at a system required L/D ratio greater than six for at least 30 continuous seconds of each of three flights, with automatic soft landing of 500 pound rectangular rigid payload streamlined by inflated fabric and provide drawings and fabrication specifications sufficient to enable the Army to duplicate units and repeat test results.

A87-328. TITLE: Analytic Support for Lightening the Force

DESCRIPTION: Develop an analysis program using LOTUS 1-2-3 spread sheet for detailed weight analysis at the battalion level. Methodology to enable "what if" exercises wherein changing one major part of an equipment item such as a track for the M-1 tank, will interactively relate the track weight, milage life, speed limitations, O&O plan, vehicle maintenance, spaces requirement, fuel requirements, support requirements, etc., for a deep battle operation of 1, 3, 5, 7, 15, 30 days to enable evaluation of impact of such a change on total weight of differently made up ballations for the selected scenarios.

A87-329. TITLE: Analytic Support for Infantry Robotics

DESCRIPTION: Perform analysis of the potential for the force multiplication, risk reduction (to friendly troops) and/or operation and support cost reduction through tactical employment of telerobotic infantry anti-armor systems for close combat light. Analysis should assess opportunities to employ these systems in the current force structure through projected force structure through 2010 and should address, as a minimum, requirements for:

- o Weapons system characteristics
- o Platform mobility (if a mobile system)
- o Level of system autonomy specifically addressing fire control
- o Approaches to system command and control (including data links)
- o New tactical employment options
- o System expendability trades
- o Sensor system and processing requirements

A87-330. TITLE: Analytic Support for Anti-Armor Heavy Robotics

DESCRIPTION: Perform analysis of the potential for the force multiplication, risk reduction (to friendly troops) and/or operation and support cost reduction through tactical employment of telerobotic anti-armor systems for close combat heavy. Analysis should assess opportunities to employ these systems in the current force structure through projected force structure through 2010. Analysis should address, as a minimum, requirements for:

- o Weapons system characteristics
- o Platform mobility (if a mobile system)
- o Level of system autonomy specifically addressing fire control
- o Approaches to system command and control (including data links)
- o New tactical employment options
- o System expendability trades
- o Sensor system and processing requirements

NAVY

Proposal Submission

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of the Assistant Secretary of the Navy (Research, Engineering and Systems). The Navy SBIR program manager is Dr. Carl E. Mueller. Inquiries of a general nature may be brought to the Navy SBIR program manager's attention and should be addressed to:

Office of Assistant Secretary of the Navy (RE&S)
Attn: Navy SBIR Program Manager
The Pentagon, Room 5E813
Washington, D.C. 20350-1000

The Navy has identified 263 technical topics to which small R&D businesses may respond. A brief description of each topic is included along with the address of each originating office. This information is contained on the ensuing pages.

SBIR proposals shall not be submitted to the above address and must be received by the cognizant activities listed on the following pages in order to be considered during the selection process.

NAVY SMALL BUSINESS INNOVATION RESEARCH PROGRAM
Submitting Proposals on Navy Topics

Phase I proposal (5 copies) should be addressed to:

Topics #N87-1 through #N87-9 and #N87-263

Mail/Handcarry Address:

Office of Naval Research
800 North Quincy Street
BCT #1, Room 528
Attn: Code OCNR 11R, SBIR Program, Topic No. _____
Arlington, VA 22217-5000

Topics #N87-10 through #N87-22

Mail Address:

Office of Naval Technology
Attn: Code OCNR 20T
SBIR Program, Topic No. ________
800 N. Quincy St.
Arlington, VA 22217-5000

Handcarry Address:

Office of Naval Technology
Code OCNR 20T, Rm. 811, BT#1
SBIR Program, Topic No. ________
800 N. Quincy St.
Arlington, VA

Topics #N87-23 through #N87-29

Mail Address:

Commandant of the Marine Corps
Headquarters, U.S. Marine Corps
Attn: Code LBC-2 SBIR Program, Topic No. ____
Washington, D.C. 20380

Handcarry Address:

Headquarters, U.S. Marine Corps
1300 Wilson Blvd., Room 604B
Attn: Code LBC-2 SBIR Program, Topic No. ____
Arlington, VA

Topic #N87-30 through #N87-43

Mail Address:

Commander
Space and Naval Warfare Systems Command
Department of the Navy
Attn: SPAWAR 10D SBIR Program, Topic No. ____
Washington, D.C. 20363-5100

Handcarry Address:

Space and Naval Warfare System Command
Room 1E58, National Center #1
2511 Jefferson Davis Highway
Attn: SPAWAR 10D SBIR Program, Topic No. ____
Arlington, VA

Topics #N87-44 through #N87-89

Mail Address:

Commander
Naval Sea Systems Command
Department of the Navy
Attn: Code CET-5 SBIR Program, Topic No. _____
Washington, D.C. 20362

Handcarry Address:

Commander
Naval Sea Systems Command
Room 924, Crystal Plaza #5
2211 Jefferson Davis Highway
Attn: Code CET-5 SBIR Program, Topic No. ______
Arlington, VA

Topics #N87-90 through #N87-96

Mail Address:

Naval Supply Systems Command
Attn: Code PML-5505 SBIR Program, Topic No. ___
Washington, D.C. 20376-5000

Handcarry Address:

Naval Supply Systems Command (PML-5505)
Advanced Logistics Technology Division
Room 606, Crystal Mall #3
1931 Jefferson Davis Highway
Attn: Code PML-5505 SBIR Program, Topic No. ____
Arlington, VA

Topic N87-97

Mail Address:

Commanding Officer
Naval Medical Research & Development Command
Attn: Naval Medical Command, National Capital Region SBIR
Program, Topic No. ____
Bethesda, MD 20814-5044

Handcarry Address:

Commanding Officer, Naval Medical Research & Development
Command, National Capital Region
Bldg. 142, Taylor Street
Attn: SBIR Program, Topic No. ____
Bethesda, MD

Topics #N87-98 through #N87-115

Mail Address:

Headquarters, Naval Air Systems Command
Department of the Navy
Attn: Code AIR-9303D SBIR Program, Topic No. ____
Washington, D.C. 20361-3030

Handcarry Address:

Headquarters, Naval Air Systems Command
Department of the Navy
Room 424, Jefferson Plaza #1
1411 Jefferson Davis Highway
Attn: Code AIR-9303D SBIR Program, Topic No. ____
Arlington, VA

Topics #N87-116 through #N87-161

Mail Address:

Naval Surface Weapons Center
White Oak
Attn: Code S-02 SBIR Program, Topic No. ____
Silver Spring, MD 20910-5000

Handcarry Address:

Naval Surface Weapons Center
Bldg. #1, Reception Room
White Oak
Attn: Code S-02 SBIR Program, Topic No. ____
Silver Spring, MD

Topics #N87-162 through #N87-167

Mail Address:

Naval Surface Weapons Center
Attn: Code S12, SBIR Program
Dahlgren, VA 22448-5000

Handcarry Address:

Naval Surface Weapons Center
Building 962, Room 129
Attn: Code S12, SBIR Program
Dahlgren, VA

Topics #N87-168 through #N87-178

Mail Address:

Commander
Naval Weapons Center
Attn: Code 005 SBIR Program, Topic No. ____
China Lake, CA 93555

Handcarry Address:

Commander
Naval Weapons Center
Room 22
515 Blandy Avenue
Attn: Code 005 SBIR Program, Topic No. ____
China Lake, CA

Topics #N87-179 through N87-187

Mail Address:

Commanding Officer
Naval Weapons Support Center
Attn: Code 6053 SBIR Program, Topic No. ____
Crane, IN 47522

Handcarry Address:

Commanding Officer
Naval Weapons Support Center
Bldg. 2917
Attn: Code 6053 SBIR Program, Topic No. ____
Crane, IN

Topics #N87-188 through #N87-193

Mail Address:

Commander
Naval Air Development Center
Attn: Code 7012 SBIR Program, Topic No. ____
Warminister, PA 18974-5000

Handcarry Address:

Commander
Naval Air Development Center
Building 1
Attn: Code 7012 SBIR Program, Topic No. ____
Warminister, PA

Topics #N87-194 through N87-206

Mail Address:

Naval Underwater Systems Center
Commercial Acquisition Department, Building 11
Attn: Code 0911 SBIR program, Topic No. ____
Newport, R I 02841-5047

Handcarry Address:

Naval Underwater Systems Center
Commercial Acquisition Department
Building 11
Attn: Code 0911 SBIR Program, Topic No. ____
Newport, RI

Topics #N87-207 through N87-212

Mail Address:

Commanding Officer
Naval Air Engineering Center
Attn: Code 9013R SBIR Program, Topic No. ____
Lakehurst, NJ 08733-5000

Handcarry Address:

Commanding Officer
Naval Air Engineering Center
Hangar No. 2
Attn: Code 9013R SBIR Program, Topic No. ____
Lakehurst, NJ

Topics #N87-213 through #N87-215

Mail Address:

Commander
Pacific Missile Test Center
Attn: Code 3141 ABIR Program, Topic No.___
Point Mugu, CA 93042-5000

Handcarry Address:

Commander
Pacific Missile Test Center
Attn: Code 3151 SBIR Program, Topic No. ___
Point Mugu, CA

Topics #N87-216 through #N87-219

Mail Address:

Naval Training Systems Center
Attn: Code 6 (SBIR), Topic No. ____
Orlando, FL 32813-7100

Handcarry Address:

Naval Training Systems Center
Bldg. 2005, Reception Area
Attn: Code 6 (SBIR), Topic No.____
Orlando, FL

Topics #N87-220 through #N87-222

Mail Address:

Commanding Officer
Navy Personnel Research and Development Command
Bldg. 329
Attn: Code 21B (SBIR), Topic No. ____
San Diego, CA 92152

Handcarry Address

Connanding Officer
Navy Personnel Research and Development Command
Bldg. 329
Catalina Blvd. & McClellan Street
Attn: Code 21B (SBIR), Topic No. ____
San Diego, CA

Topics #87-223 through #N87-225

Mail Address:

Commanding Officer
Naval Civil Engineering Laboratory
Attn: Code L03B-SBIR Program, Topic No. ____
Port Hueneme, CA 93043

Handcarry Address:

Commanding Officer
Naval Civil Engineering Laboratory
Building 560, Attn: Code L03B-SBIR Program, Topic No. ____
Maritime Road & Market Street
Port Hueneme, CA

Topics #N87-226 through #N87-232

Mail Address:

Commanding Officer
Naval Air Propulsion Center
Attn: Code PE1A - SBIR Program, Topic No. ____
P.O. Box 7176
Trenton, NJ 08628-0176

Topics #N87-233 through #N87-239

Mail Address:

Commanding Officer
Naval Ocean System Center
Attn: Code 0141 - SBIR Program, Topic No. ____
San Diego, CA 93555

Handcarry Address:

Commander
Naval Ocean Systems Center
271 Catalina Boulevard
Trailer 28T
Attn: Code 216B Supply Annex, Topic No. ____
San Diego, CA

Topics #N87-240 through #N87-249

Mail Address:

Commander
David Taylor Naval Ship
Research & Development Center
Attn: Code 003 - SBIR Program, Topic No. ____
Bethesda, MD 20084

Handcarry Address:

Commander
David Taylor Naval Ship
Research & Development Center
Attn: Code 003 - ASBIR Program, Topic No. ____
Building 2, Room 101
Carderock, MD

Topics #N87-250 through #N87-251

Mail Address:

Commanding Officer
Naval Avionics Center
6000 East 21st Street
Attn: Code 801, SBIR Program, Topic No. ____
Indianapolis, IN 46219-2189

Handcarry Address:

Commanding Officer
Naval Avionics Center
Administration Bldg., Room 207
6000 East 21st Street
Attn: Code 801, SBIR Program, Topic No. ____
Indianapolis, IN

Topics #N87-252 through #N87-262

Mail Address:

Commander
Naval Air Test Center
Attn: Code CT-24, SBIR Program, Topic No. ____
Patuxent River, MD 20670-5304

Handcarry Address

Commander
Naval Air Test Center
Building 304
Attn: Code CT-24, SBIR Program, Topic No. ____
Patuxent River, MD

N87-1. TITLE: Eye-Movement Instrumentation For Dynamic Skills

CATEGORY: Exploratory Development

DESCRIPTION: A need exists for an automated eye-movement recording and analysis system that would be minimally disruptive to a person engaged in the performance of a task involving whole body motion, such as the control of aircraft landing on a carrier or the performance of an instructor in the classroom. This system must include a capability to record both eye-movements and the scene being viewed in such a way that the information can be correlated with a reasonable degree of precision. It should provide capability for automated superposition of eye-movements on a video-display of the scene and for recording of that information, as well as for digital recording of data in a form readily usable for standard methods of eye-movement data analysis. Techniques for easily entering information about the location of objects in the video scene should also be provided, such as automated encoding of the location of a light pen. Automated techniques for tracking the location of an object once it has been designated in the video scene would also be highly desirable. To the maximum extent possible, the system should be constructed from standard components that are commercially available, and software should be written in a standard, widely available language. Provided that a sufficiently convincing design concept is presented and expected costs are not excessive, proposals that include prototype construction will be considered and given preference.

N87-2. TITLE: Marine Instrumentation Systems

CATEGORY: Research

DESCRIPTION: Develop innovative techniques for remotely mapping the temporal evolution of three-dimensional coherent structures (e.g., turbulence cells; wave signatures; vortical motion; Langmuir circulation; bubble clouds and plankton patches), providing scalar and vector fields with precision and spatial/temporal resolution adequate to test dynamical hypotheses. Required are unmanned systems or system components designed to acquire reliable, long-term measurements at sea. Modular elements with standardized intefaces include:

innovative sensors for state and action variables within the ocean and atmosphere boundary layer;
programmable, adaptive, low power, control and mass storage devices;
telemetry transmitters, both acoustic and electromagnetic; and
autonomous surface and/or subsurface platforms, either fixed position, free drifting, or navigable.

N87-3. TITLE: Red Blood Cell Substitutes

CATEGORY: Exploratory Development

DESCRIPTION: A need exists to increase the supply of biomedical materials capable of delivering oxygen to tissues for combat casualty care and for national emergencies. Approaches currently being developed by the Navy include: 1) enzymatic modification of natural red cells to remove A and B blood type determinants, converting them to Type O or universal donor blood cells, and 2) synthesis of artificial red cells using liposome-encapsulated hemoglobin. Modifications of or alternatives to these biomedical materials are being sought that deliver oxygen efficiently, evade clearance by the reticuloendothelial system and which fail to activate clotting systems.

N87-4. TITLE: Immunopharmacology

CATEGORY: Research

DESCRIPTION: A need exists for pharmacologic agents that can activate immune defenses against microorganisms, especially viruses. Agents that activate either non-specific or specific immunity are of interest, but immune stimulants that protect against a wide variety of infections non-specifically are of special importance to military medicine. Both prophylactic and therapeutic pharmaceuticals are of interest. Suitable pharmaceuticals must be potentially safe for human use, economical to produce, convenient to use, and enhance resistance to or recovery from infectious agents.

N87-5. TITLE: Spatial Statistics

CATEGORY: Research

DESCRIPTION: Data about phenomena unfolding in space and time are now collected in large amounts, often continuously by automated systems, in disciplines and technologies as diverse as in radar imaging, geology, oceanography, and remote sensing. The common distinguishing feature of these data is the typical existence of patterns which express the underlying interactions between entities observed in space. The purpose of spatial statistics is to uncover the patterns in data about spatio-temporal phenomena. The proposed research includes:

- A comprehensive approach to modeling and inference for space-time processes.
- Model-free strategies to assess the variability of statistics of spatial data.
- Robust inferential procedures for spatial point processes.
- Graphical methods to reveal complex structures in multidimensional data.

N87-6. TITLE: Miniature Capillary Pumped Heat Transfer Component

CATEGORY: Exploratory Development

DESCRIPTION: Several classes of new electronic devices would perform much better if waste heat could be removed from them efficiently at moderate operating temperatures, high density digital circuits and con-

centrator solar cells being two examples. For some applications such as high concentration ratio photovoltaics, heat removal is an enabling technology. What is needed is a component of low weight subtending a very small volume which can remove up to 50 watts/cm^2 at near room temperature without requiring a pump. Standard heat pipes are far too bulky and heavy for many applications, and most standard designs don't perform well near room temperature anyway. Hopefully the techniques used in silicon microcircuit fabrication could be employed to produce numerous closely spaced grooves through which a liquid heat transfer fluid might flow by capillary action evaporating to absorb the waste heat, thus forming an array of miniature capillary pumped loops. The advantages of forming such an array in a silicon substrate are considerable, since material incompatibilities between waste heat rejection components and active electronic devices are eliminated at the outset.

N87-7. TITLE: <u>Environmentally Stable Fluoropolymers</u>

CATEGORY: Research

DESCRIPTION: The overall goal of this work will be to understand structure property relationships in fluoropolymers with regard to how composition and morphology determine processability and acoustic propagation velocities. Fluoropolymers have long been known to exhibit high environmental stability combined with low surface energy (e.g., ice release coatings, fouling release coatings). In addition, recent results have shown that certain fluoropolymers can exhibit very low acoustic propagation velocities. A problem with many attractive fluoropolymers is their intractability toward processing. Teflon™ for example is impossible to melt or solution process. What is sought then is novel polymer chemistry aimed primarily at glassy or thermoset polymers (though other sorts are not necessarily excluded) which will have processability in casting or molding. This will be coupled with physical characterization so as to determine pertinent structure property relationships. The results of this work will have great impact in the area of advanced naval materials for underwater acoustic applications such as sonar domes.

N87-8. TITLE: <u>Processes For Producing Multicomponent Ultrafine Microstructures</u>

CATEGORY: Research

DESCRIPTION: There is increasing interest in materials having multicomponent ultrafine microstructures (i.e. a microstructural scale of 1 to 100 nm) and therefore useful mechanical, magnetic or optical properties. Processes are needed which can produce microstructures comprising two or more phases, with emphasis on metals and ceramics, which can not be produced by solidifying the corresponding liquid. Fully dense materials having a granular or filamentary, vs. laminar, microstructure are of primary interest. Examples include ultrafine composites containing particulate tougheners/strengtheners, ultrafine metal granules embedded in a low conductivity matrix, cermets with bicontinuous phases,

and unusual combinations of ceramics. The objective of this research is to explore the capabilities of processes which can produce such materials, in particular by understanding the mechanisms which determine the resultant microstructure as a function of process parameters.

N87-9. TITLE: Turbulent Vortex Flows Due To Unsteady Body Motion

CATEGORY: Research

DESCRIPTION: Computational and Experimental work directed towards understanding the flow physics involved in vortex motions generated by unsteady body motion is desired. Purely laminar flows are not of interest. Instead transitioning and turbulent flows are of interest. Analytical efforts should have the three dimensional Reynolds Averaged Navier Stokes equations as the lower order model acceptable. The role of turbulent models in such calculations is of extreme interest. Comparison with existing cases for code verification should be considered as part of the work. Experimental work that deals with developing instrumentation to obtain quantitative information for such flows is acceptable. However, priority will be placed on efforts that offer quantitative information for such flows and how control devices might be used to control unwanted events in unsteady flows. The flow regimes of interest range from low speed to supersonic.

N87-10. TITLE: Improved Ordnance Life-Cycle Affordability

CATEGORY: Exploratory Development

DESCRIPTION: The objective of this project is to quantify how technology developments can improve ordnance life-cycle affordability in an extended time-frame (POM + 15 yr). Based on projected ordnance technology advancements forthcoming, this effort will investigate and develop an ordnance life-cycle affordability model flexible enough to accommodate both inventory affordability and the future capability degradation of the most modern ordnance in that inventory due to advancing threats and end of service life. It is recognized that precise definition of ordnance degradation is complex and difficult. This effort will build on existing older-models which have derived such ordnance degradation factors.

N87-11. TITLE: Composite Materials As Electronic Device Substrates

CATEGORY: Exploratory Development

DESCRIPTION: Electronic devices generate large quantities of heat which produces thermal expansion mis-match problems resulting in bond-line failures and significantly reduced device lifetimes. Recent advances in composite materials offer the opportunity to exploit their potential as thermally stable heat sink substrates for the heat-producing microchips. Composite matrices (carbon, metal, ceramics and organics) reinforced with fibers (graphite, silicon carbide, aluminum oxide, etc.) can be combined to produce a substrate tailorable to the specific heat sink and thermal

expansion requirements of a wide variety of electronic devices. The objective of the proposed effort should be the design of selected composite systems and the demonstration of their utility as thermal expansion-matched heat sinks for electronic devices. The bidder should have background in composite materials and electronic devices. As an alternative, a teaming arrangement between composite materials and electronic device companies should be considered.

N87-12. TITLE: Micron Scale Lithography On Concave Surfaces

CATEGORY: Exploratory Development

DESCRIPTION: The development of micron scale lithography is needed for several Navy cathode applications: (a.) very low-cost integral cathode/heater/grid structures for expendable TWTs, (b.) micron scale porosity for high brightness millimeter wave controlled porosity dispenser cathodes, and (c.) integral shadow and control grids for such cathodes. These cathodes range in diameter from a few millimeters to several centimeters and have various spherical radii of curvatures of a few X the diameter. Optical lithography has not been useful here because of short depth of focus; but masked ion beam, X-ray, or e-beam lithography may be possible. Patterning of 2-5 micron slots on 20-30 micron centers with 100-200 micron lengths is needed in mm-size fields which do not have to be accurately stitched (Pattern-transfer by means of ion milling or reactive ion milling is envisioned, in mask materials in which erosion is low).

N87-13. TITLE: Development Of Diver Monitoring Equipment

CATEGORY: Exploratory Development

DESCRIPTION: Divers and combat swimmers continually conduct operations in hostile environments during which physiological limits are approached and on occasion, exceeded. There is a critical need to monitor physiological variables while a diver or combat swimmer is free to move about conducting normal underwater tasks. The physiological variables of interest include heart rate, heat flow, temperature, electromyogram, and respiratory rate. The equipment would be used to monitor the above variables on as many as six divers from a distance of up to two miles. The transmission of the data should involve wireless methods and it is desirable that the data from each diver can be stored for transmission when signalled by the investigator. The envisioned development effort will produce a prototype device for use in the study of diver physiology. The Navy is keenly interested in diver and combat swimmer physiology under a variety of conditions and this device will allow the appropriate studies to be made.

N87-14. TITLE: Modeling Of Shipboard Electric Power Distribution System

CATEGORY: Exploratory Development

DESCRIPTION: The objective of this work is to develop an approach to mathematically model the steady-state and transient behavior of a shipboard electrical power distribution system. Such a model would include multiple engine-generators, cabling, distribution breakers at three (3) levels and multiple loads. Loads would include linear, non-linear and pulsed types. The output of the work should be a computer model useable by the Navy to analyze the behavior of shipboard distribution systems. The level of detail should be sufficient to include both 60 Hz and 400 Hz harmonics. The availablility of such a model would allow trouble shooting distribution system problems without elaborate experimental measurements, better design of system modifications and new systems, and provide the means to assess the impact of new technology and equipment on the distribution system.

N87-15. TITLE: Electrical Fault Current Limiter

CATEGORY: Exploratory Development

DESCRIPTION: Develop small, low-cost device(s) to limit current into a short circuit under fault conditions. Such a device would exhibit very low voltage drop under normal conditions, react nearly instantaneously to an overcurrent, and be self healing; i.e., revert to the normal state when the fault is removed. Fault current limiters can be used to reduce the effect of faults in one portion of a distribution system on the unaffected portions, thus maintaining power continuity to vital loads. Further, the short circuit current carrying and interrupting ratings of breakers could be reduced, resulting in smaller breakers and/or the ability to parallel multiple power sources without increasing breaker ratings. Devices with normal state current ratings in the range of 15 to 5000 Amperes are of interest. Small size and low cost are mandatory for practical application.

N87-16. TITLE: Machinery System Noise Model

CATEGORY: Exploratory Development

DESCRIPTION: The objective of this project is to develop computer software for comparative analysis of torsional vibrations in main propulsion drive trains for Navy ships. Successful software development would provide a tool for conducting comparative evaluations of the noise (on a relative basis) of alternative machinery systems. This would permit machinery noise to be considered on an equal level with other performance characteristics such as size, weight, and efficiency when conducting comparative evaluations of alternative machinery systems for future ship applications. The user should be able to specify the amplitude, frequency and point of application of the torques which excite the system. The primary outputs generated by the software will be the ratios of the oscillation amplitudes at any junction in the system to exciting torque amplitude as a function of frequency.

N87-17. TITLE: Power Amplification For Underwater Electroacoustic Transducers

CATEGORY: Exploratory Development

DESCRIPTION: Design, develop and demonstrate a compact, highly efficient (greater than 60% power converion) power amplifier that will self tune over a bandwidth of at least one octave about a resonant frequency of an underwater electroacoustic transducer. At the selectable "tuned" frequency, the system must efficiently produce a high-fidelity and high-power acoustic signal. Available electric battery power would be in the 1-1.5 KW range with output underwater acoustic levels in the 190-210 dB re 1 uPa range. Nominal frequencies considered should be 0.5-200 kHz.

N87-18. TITLE: Mine Warfare Tactical Theory And Planning Methodology

CATEGORY: Exploratory Development

DESCRIPTION: Development of minefield and mine countermeasure theory and related analytical models which can treat the entire stockpile-to-target sequence and be used to evaluate complex multiport and campaign level scenarios. Near term application of this improved methodology will allow more realistic predictions of the effectiveness of various minefield designs; permit more efficient utilization of available mining assets; provide a capability to accurately determine stockpile requirements; and realistically compare the attributes of new mine design concepts.

N87-19. TITLE: Detection Of Non-Metallic Objects

CATEGORY: Exploratory Development

DESCRIPTION: There is a requirement for developing a capability to locate small, non-metallic objects on the surface or shallowly buried, both on land and/or in the surfzone. It is further required that the chosen technology be effective in a variety of soils and under all weather conditions. Also desired, but not required, is the capability of incorporating the resulting design into a man portable configuration.

N87-20. TITLE: All Metals Locator

CATEGORY: Exploratory Development

DESCRIPTION: The Navy requires an active all-metals locator for detecting and locating ordnance with metal components. The locator should be a hand-held, one-man operable device for both surface and underwater use to 300 feet depth. It should have the following capabilities and characteristics:

Detection Range: 1-inch by 1/4 inch brass pin at 20-inches minimum.
Operational Weight: 15 pounds maximum.
Underwater Operational Depth: 300 feet.
Operational Time: 8 hours.
Operating Temperature Range: 125°F to -30°F
Power Supply Type: Commonly available batteries.

The locator would need to be rugged and reliable in all field scenarios requiring disposal of explosive ordnance.

N87-21. TITLE: Enhanced Undersea Warheads

CATEGORY: Exploratory Development

DESCRIPTION: Warhead concepts capable of producing enhanced damage to ships and submarines for weight and volume limited undersea weapons systems are needed. These concepts include, but are not limited to, explosive compositions having increased output, focused blast warheads where the shock wave energy is concentrated in the direction of the target, shaped charge warheads incorporating new metals or bimetals and/or liner shapes, long rod penetrators, explosively formed projectiles, etc. For each concept, analytic tools such as finite element codes should be used to define the warhead design and its performance capability against specified targets. Experiments at sub-scale against simple targets should also be conducted to validate these analytic results. The end product should be a warhead concept whose feasibility has been demonstrated on a preliminary basis.

N87-22. TITLE: Innovative Methods For Submarine Detection

CATEGORY: Exploratory Development

DESCRIPTION: Develop innovative methods of submarine detection using advanced techniques. One of the key factors in maintaining sea control, in the event of a conflict, is our Navy's ability to detect and defeat hostile submarines. This task solicits innovative proposals to accomplish the detection part of this effort. Respondees should examine emerging technologies for potential application to submarine detection systems, develop system concepts, and recommend those seeming to offer the highest potential for further development. Factors of cost, feasibility, sweep rate, and reliability of detection should receive careful consideration in the development of proposed concepts. The ability of proposed systems to operate under a variety of weather and oceanographic conditions as well as their ability to localize a potential submarine target to a small area will also be considered in the selection of concepts. Especially promising concepts will be considered for further development.

N87-23. TITLE: Variable Speed Compatible Refueling Drogue For Air Refueling Fixed/Rotor Wing Aircraft

CATEGORY: Engineering Development

DESCRIPTION: At present, the mission of refueling both fixed wing and helicopter aircraft cannot be accomplished without air equipment change to the refueling pods. This is due to the design of the high speed drogue that will not support the weight of the refueling hose at the lower speeds required for the helicopter refueling. The challenge is to develop a drogue that will support the 80 foot refueling hose at airspeeds between 105 KIAS and 250 KIAS. The goal of this study should result in

the development of a design proposal of a flight worthy engineering development model of a variable speed compatible aerial refueling drogue.

N87-24. TITLE: Communications Skills For Base And Station Communications-Electronics Officers (CEO'S)

CATEGORY: Management and Support

DESCRIPTION: Base and station communications skills are not the same as tactical skills, yet the Marine Corps provides little or no special training to officers or senior staff NCO's assigned to billets as base or station CEO officers. Required communications and related functions and skills need to be identified, qualified, and recommendations made to implement an effective training program.

N87-25. TITLE: Translation Of Jams Software From "C" Language To Ada Language

CATEGORY: Engineering Development

DESCRIPTION: JINTACCS Automated Message System presently is written in the computer language "C". Due to the now available ADA compilers and DOD direction, conversion to ADA language is opportunistic at this time. This conversion requires the translation of approximately 500,000 bytes of code.

N87-26. TITLE: Fibre Optic Cable Recovery System

CATEGORY: Exploratory Development

DESCRIPTION: Both the teleoperated vehicle (TOV) and the airborne remotely operated device (AROD) anticipate the employment of fibre optic cable over considerable distances both in training and in combat operations. Marine Corps units require the means to recover deployed fibre optic cable expeditiously to relieve logistic aspects of TOV/AROD operations and to limit the expense of both training and combat operations. As a design point, the system needs the capability to recover fibre optic cable at a rate of 15 km/hr (higher rate if terrain permits) on one spool without damage to the fibre optic cable. The purpose of the system is to recover the fibre optic cable for subsequent respooling. The system needs to be mountable on a HMMWV, to require no more than two Marines, to be powered by HMMWV sources and to be simple in design for field maintainability. The task is a three-phase undertaking in which the Phase I is a feasibility study. Phase 2 is the fabrication effort derived from the considerations of Phase 1. Phase 3 is the demonstration validation of the recovery system design.

N87-27. TITLE: Tactical Warfare Simulation Evaluation Analysis System (TWSEAS)/Aviation Systems Interface

CATEGORY: Advanced Development

DESCRIPTION: Produce a report indicating the most effective means of interfacing the TWSEAS with the current and projected Marine Air Command and Control Systems (MACCS) at the Marine Amphibious Brigade and Force levels. Complicating this problem is the fact that the MACCS are already largely automated. The goal of this interface is to provide exercise information to the wing command elements which will allow them to participate in integrated exercises with the other elements of the Marine Amphibious Brigade and Marine Amphibious Force.

The TWSEAS is a computer assisted, real time tactical exercise control system which can monitor actual events as they occur in field exercises and as reported by umpires using digital communications links. In the command post exercise where only the player's command post is real, TWSEAS simulates the battlefield environment, reports the actions of all simulated units and calculates/reports all combat damage as a result of actions of forces on both sides of the engagement. Combat information must reach the player's command post in a manner which is the same as, or at least very close to, that which is present during actual battle.

The MACCS environment contains numerous automated systems with new versions currently being developed. These systems include the Advanced Tactical Air Command Center, the aviation portion of the Tactical Combat Operations System, and the Tactical Air Operations Module. The training target elements in the MACCS are not the air controllers, but rather, the command staffs.

This effort should include an analysis of the most beneficial point(s) of interface to exercise the MACCS command elements. Factors such as the amount and type of required information, and appropriate transfer points shall be included. As a follow-on effort, Interface Design Specifications could be prepared for the specific interfaces defined in the initial effort. These specifications shall be in accordance with Military Standard 2167 (or current version thereof).

N87-28. TITLE: Tactical Warfare Simulation Evaluation Analysis System/Marine Integrated Fire And Air Support System Interface

CATEGORY: Advanced Development

DESCRIPTION: Produce an Interface design Specification, in accordance with Military Standard 2167 (or current version thereof), and an operational concept of employment for the interfacing of the Tactical Warfare Simulation Evaluation Analysis System (TWSEAS) and the Marine Integrated Fire and Air Support System (MIFASS).

THE TWSEAS is a computer assisted, real time tactical exercise control system which can monitor actual events as they occur in field exercises (FEX) and as reported by umpires using digital communications links. In the command post exercise (CPX) where only the player's command post is real, TWSEAS simulates the battlefield environment, reports the actions of all simulated units and calculates/reports all combat damage as a

result of actions of forces on both sides of the engagement. In order to be successful, combat information must reach the player's command post in a manner which is the same as, or at least very close to, that which is present during actual battle. The TWSEAS must interact with the player's command and control systems. In the future, this command and control environment will include MIFASS. MIFASS will be a command and control system which will integrate artillery, mortars, naval gunfire and air support with the unit scheme of maneuver. Since supporting arms actions form a large part of the combat exercise environment, there is a clear need for the TWSEAS and MIFASS to interface.
This effort shall include the software and hardware issues involved in the interface as well as an analysis of the level on interface required (i.e., manual, semi-automatic or automatic). This analysis should be supported by the operational and training requirements present during an integrated (i.e., combined FEX/CPX) exercise involving Marine Air Ground Task Forces at all three levels of command (Marine Amphibious Unit, Brigade, and Force). These requirements include the need to present various information to the exercising staff via these command and control systems as well as the need to create a realistic environment through the simulation of the player's real command and control systems.

N87-29. TITLE: Mechanical Differential Steer Drive Unit For Amphibious Tracked Vehicles

CATEGORY: Engineering Development

DESCRIPTION: The current hydrostatic steer unit and transmission assembly for the AAAV7A1 have experienced a high failure rate in testing and operational use. A mechanical steer drive unit has potential for drastically reducing failure rate, initial procurement cost, as well as overall life cycle costs. Additionally, reliability, availability and maintainability and vehicle performance could be appreciably improved.

Adapt existing designs (commercially available differentials, gears, transfer cases, etc.) into a mechanical steer drive unit and control system that would allow for assembly and installation into an Assault Amphibian Vehicle 7A1 (AAV7A1).

N87-30. TITLE: Frequency Stabilization In Pulsed Laser Waveforms

CATEGORY: Advanced Development

DESCRIPTION: A significant problem in developing a pulsed coherent laser system is the control and minimization of frequency jitter (intra-and inter-pulse) in pulsed waveforms. Current approaches involve the development of ultra stable Master Oscillators and utilization of Power Amplification (MOPA) stages. While effective, this approach leads to large and relative inefficient laser transmitters. An innovative approach is needed to allow the utilization of smaller, less complicated and more efficient laser sources which can still maintain critical levels of frequency stability. In general, this technique must be applicable in a system producing high repetition frequencies (PRFs) and

peak power.

A potential solution to this problem would be the measurement of frequency instabilities and modification of the frequency content of a pulse prior to the transmission. An approach based on modifying successive pulses would not be satisfactory, since from pulse to pulse there is little correlation in intra-pulse frequency jitter. In particular, the frequency stability required is so severe that even CW systems require intricate design and fabrication procedures to achieve it. Proposed approaches will have to describe the process, determine the level of frequency stability, and determine what power level can be achieved.

N87-31. TITLE: Broadband Acoustic Characterization

CATEGORY: Advanced Development

DESCRIPTION: Further improvement in detectability of broadband underwater acoustic radiated energy depends upon more detailed characterization of that energy and application of sophisticated signal processing techniques to capitalize upon particular features for detection, classification and localization. This task involves processing of real acoustic data with utilizatiion of innovative software tools to parameterize the broadband signature characteristics by quantifying spectral, correlation, statistical or other applicable methodology products. This detailed characterization can be utilized in further, carry-on tasks to develop algorithms for detection and classification and to identify possible sources of the broadband energy.

N87-32. TITLE: Automated Broadband Detectability

CATEGORY: Exploratory Development

DESCRIPTION: Utilize characterizations and parameterizations of broadband underwater acoustic radiated energy and real target characteristic maneuvers to develop innovative approaches to target detection tracking and classification. Both the target signature and the target dynamics should be accounted for to produce automatic operator alerts, measure parameters useful for multiple hypothesis classification group sorting and associate sporadic contacts with multiple acoustic contacts.

N87-33. TITLE: High Power Microwave Antenna Development

CATEGORY: Exploratory Development

DESCRIPTION: New high power microwave source devices under development require an associated development of antenna technology. The high power microwave antenna performance characteristics required include the ability to project gigawatts of effective radiated power with superior gain and sidelobes which are down 80 db from beam main lobe intensity. A modified phased-array design is thought to represent the best compromise solution for the conflicting performance requirements. The Phase I

Small Business Innovative Research effort needed is a preliminary design calculation based upon first principles and innovative fabrication concepts.

N87-34. TITLE: Submarine Communication In Direct Support Of A Battle Group

CATEGORY: Advanced Development

DESCRIPTION: There is a need for covert means for a submerged submarine in direct support of a Battle Group to communicate with the Battle Group Commander or other members of the Battle Group. The objective(s) of this task is to provide a reasonably covert means of communication between a submerged submarine and members of a Battle Group (Battle Group Commander/Composite Warfare Commander). As a minimum, the communication system should: have an availability of 0.90; be reasonably covert; impose a minimum restriction to submarine operations and tactics; to the maximum extent possible, utilize equipment which is presently on board surface ships and submarines; NOT require the submarine to surface, or expose radar antennas above the surface to communicate; obtain a minimum communication range of 10 nautical miles, at a signal-to-noise ratio of 10 db, data rate of 100 bits per second with an error rate not greater than ten to the minus four. The end result of this task will be: A literature search and requirements analysis; a communication system technical analysis and risk assessment; and a system definition.

N87-35. TITLE: Data Compression For Naval Messages (ADM/EDM)

CATEGORY: Advanced Development

DESCRIPTION: Data compression can be applied to naval record message systems to increase their throughput and efficiency. This task will investigate the cost and benefits to be derived from the application of data compression techniques to a target naval record message processing system specified by the Navy. Analysis will be performed to identify viable compression techniques and to quantify the resulting increases in system throughput. Implementation requirements, such as the need for new compression equipment and/or the use of existing processing and storage capabilities to support compression functions, will be considered. Candidate compression techniques to be investigated include both reversible and non-reversible and semantic dependent and independent techniques. Examples are null suppression, bit mapping, run length encoding and that broad class of statistical methods represented by Huffman encoding. Chaining (sequential application of different techniques) will also be considered. Compression ratios of the order of 2:1 (resulting in approximately a doubling of system throughput) will be sought with no degradation in system error performance. A follow-on task will establish the performance of the candidate compression technique(s) through benchmark testing. Compression performance test results will provide the basis for subsequent preparation of program plans and system specifications for the implementation of data

compression within a naval message system.

N87-36. TITLE: Low Cost Pointing And Tracking System For Optical Communications

CATEGORY: Advanced Development

DESCRIPTION: Free space optical communications could become an important mode of information transfer between ships that are within line of sight. Optical communication emitters and detectors have become readily available at low cost as have many other critical components. These devices can support the very high data rates needed for modern naval sensors and command and control. However, subsystems for the pointing and tracking of these optical signals continue to be difficult to build due to the high precision required of the mechanical gimbals. Their costs dominate the overall cost for free space optical communications. What is needed are innovative approaches to pointing and tracking including control system theory, the mechanical assemblies, and the means for their economical production. Microprocessors, for example, could be used to implement a complex algorithm that would be used with a simple mechanical assembly with loose tolerances to provide accurate tracking and pointing. Production of an accurate pointing and tracking system would be significantly easier because of the loose tolerances on the mechanical assembly and low cost of microprocessor electronics. Other innovative approaches could prove to be even more attractive. Proposals should focus on the potential of low cost and ease of production along with the innovative aspects.

N87-37. TITLE: Tactical Packet Transmission

CATEGORY: Advanced Development

DESCRIPTION: The large number of systems desiring access to the HF, VHF and UHF tactical communications channels (existing and planned), the increasing volume of traffic from those users presently using the channels and the need for faster communication with the community lead to a severe problem in the use of very limited assets. The traditional method has been to "add another circuit"; however, the spectrum is presently so crowded that this is not a satisfactory solution. The use of packet transmission schemes for the transmission of data and voice is not only feasible, but appears to be practical. The task is to document the circuits required for the Atlantic Fleet and then develop approaches to allow an evaluation of the implementation problems.

N87-38. TITLE: Adaptive Techniques To Improve HF Communications

CATEGORY: Advanced Development

DESCRIPTION: The use of High Frequency radio to transfer command and control information in the battle force is expected to continue for the foreseeable future. The use of adaptive techniques to improve the performance of HF in a noisy environment appears to have potential. The

task is to explore the threats to HF communications and propose solutions. The solutions must be evaluated in terms of cost, size, implementability and benefit. A follow-on effort, if desirable, will be to brassboard a system and develop system specifications.

N87-39. TITLE: Development Of Covert Communications Applique

CATEGORY: Advanced Development

DESCRIPTION: Develop an applique to lower the detectability of existing VHF or UHF radios so that they can be used for special communications from ship to ship or other operations requiring limited range communications. Obvious techniques such as power reduction and signal spreading techniques will be considered. Innovative methods for low cost implementations should be considered. Radios to be considered should include: WSC-3, PRC-117, and ARC-182.

N87-40. TITLE: Arctic Meteor Burst Communications

CATEGORY: Advanced Development

DESCRIPTION: Increased Soviet submarine threat levels in the Arctic (both strategic and tactical) have driven a corresponding U.S. emphasis for increased Arctic operational capabilities. U.S. Submarines must be capable of communications with beyond line of sight (BLOS) shore stations while remaining below the ice layer. Furthermore, a report back capability must be developed which is independent of satellites (due to their vulnerability), resistant to nuclear ionospheric effects, difficult to jam or intercept, and has high throughput. Meteor burst communications offer such an alternative. The objective of this effort will be to develop an ice penetrating expendable meteor burst buoy. Coordination with current effort to develop ice penetrating techniques is mandatory. The first phase of this effort will consist of a review of current and buoy design. The second phase, if desireable, will consist of refining buoy design to ensure power, frequency (30-100 MHz) and size requirements are met. A prototype buoy will then be built and tested in conjunction with a schedule ice exercise.

N87-41. TITLE: Software Programmer Productivity

CATEGORY: Advanced Development

DESCRIPTION: The Defense Department urgently needs ways of increasing the productivity of individual computer programmers in an effort to reduce the sizable costs of software intensive programs. Practically all major procurements nowadays require a large investment in applications programming and the general level of industrial productivity in this area is quite low...1 to 5 lines of code per day per programmer on a gross average. Dramatic increases in productivity would permit faster development which would quickly recoup the research investment. Furthermore, it would permit larger sized programs to be undertaken with obvious application to the Strategic Defense Initiative as well as Navy

Command and Control Programs. All technical approaches to increasing productivity will be entertained.

N87-42. TITLE: Software Development Measures Of Performance

CATEGORY: Advanced Development

DESCRIPTION: The Defense Department urgently needs ways of measuring progress of software development in software intensive systems. Although reasonably analytic methods are available to Navy and Defense contractors today, they often consist of "score keeping" of software modules undergoing design, coding, integration, and test. Is there a way, for instance, of measuring the complexity of modules or entire systems with a view toward accurate cost and schedule data before the fact, and tracking the effort accurately during the development? A survey of available methods is not what is expected. Original work, building on today's state-of-the-art is required.

N87-43. TITLE: Low Cost Electronic Warfare Systems For Remote Operated Vehicles

CATEGORY: Advanced Development

DESCRIPTION: The U. S. Navy has needs for compact, low cost electronic warfare systems to be carried by remote operated vehicles. These will be used for surveillance and for countering threat surveillance, missile attacks and data links. Design work is required for electronic countermeasure techniques and frequency set-on generators integrated with a microprocessor controller that will provide autonomous and remotely cued countermeasure responses coordinated with the tactical deployment of the remote operated vehicle.

N87-44. TITLE: Torpedo Mk 46 Exercise Configuration Recovery Subsystem

CATEGORY: Engineering Development

DESCRIPTION: The Torpedo Mk 46 exercise weapon is recoverable at end of run through a system of lead weights which are released at a predetermined depth. The loss of the lead weights then makes the weapon positively buoyant; it rises to the surface and is recovered. The current design employs explosive bolts (NALC DN61) which are fired at the specified depth and which then release the lead weights (approximately 70 lbs). Although generally satisfactory, this method has been the source of several problems. The explosive bolt has proved difficult for several contractors to make and without them, the Fleet exercise program can be curtailed. Secondly, once the bolts fire and release the lead weights, the residual bolt body must effectively seal the torpedo exercise head against seawater contamination at great depths. Contamination of the exercise head can result in loss of that expensive component. What is needed is an alternate method to release the lead weights that does not require the use of other expendables such

as explosive bolts and which is simple, reliable, and effective.

N87-45. TITLE: Broadband Transducer/Amplifier Techniques

CATEGORY: Advanced Development

DESCRIPTION: Tuning techniques are required to permit efficient excitation of a broadband, high power sonar projector over a minimum octave frequency band around the mechanical resonance of the transducer. The amplifier types that may be used to excite the transducer would be either of a switch mode or linear variety. Techniques involving the phenomenon of negative capacitance and/or variable tuning are candidates for investigation.

N87-46. TITLE: Improved Maintenance Aids

CATEGORY: Engineering Development

DESCRIPTION: Current maintenance practices onboard ship involve tech manuals and maintenance/repair cards which are bulky to carry around, not easy to follow and at times difficult to keep up to date. This solicitation is for a small demonstration hardware system using the latest technology in storage, graphics, interactive displays and voice to "automate" a small and selected set of current maintenance aids. The demonstration system should be highly portable, very user friendly and can prompt or lead the troubleshooter through the procedures without referencing current documentation.

N87-47. TITLE: ASW Search Planning

CATEGORY: Advanced Development

DESCRIPTION: Develop search planning methods for optimizing asymmetrical detection performance (i.e. detection performance which is non-uniform in azimuth due to beam dependent noise and (or) propagation loss). Apply these methods to sonar performance prediction/lineup and search planning methodology.

N87-48. TITLE: Flexible Fusion Splices For Optical Fiber

CATEGORY: Engineering Development

DESCRIPTION: A need exists for a technique to achieve flexible fusion splices of optical fibers in the field. This technique will be critical to the practical utilization of optical fiber sensor technology in an operational environment. The resulting spliced and coated fiber should have nearly the same physical characteristics as the fiber on either side of the splice. Bend radius and hermeticity would be two parameters of concern.

N87-49. TITLE: Environmentally Stable Singlemode Fiber Optic Couplers

CATEGORY: Engineering Development

DESCRIPTION: Environmentally stable, singlemode fiber optic couplers are critical components for virtually every fiber optic sensor and transmission system. There is a need to develop fabrication techniques for low cost, high volume production of these components. Particular attention should be given to the potential for automation and the application to polarization preserving fibers.

N87-50. TITLE: Shallow Water Sonar System

CATEGORY: Advanced Development

DESCRIPTION: There is a need for a shallow water sonar system (shallow water 40 - 1000 fathoms). System will be used on small ships so it should be light weight (10 metric tons or less). Target detection should be 15K yds. or more consistently. System should be able to detect, classify, localize and prosecute the threat without other sensor assistance.

N87-51. TITLE: Pigtailed Singlemode Laser Diodes

CATEGORY: Engineering Development

DESCRIPTION: Pigtailed laser diodes are critical components for all fiber optic sensor systems. There is a compelling need to develop fabrication techniques for pigtailing singlemode laser diodes, particularly towards achieving automated fabrication processes for low cost, volume production. Manually pigtailed singlemode laser diodes are available from a limited number of suppliers, but fabrication techniques are costly, time consuming and have a low yield rate.

N87-52. TITLE: Fine Metal Reinforcements For Ceramic Composites

CATEGORY: Exploratory Development

DESCRIPTION: With the advent of ceramic matrix composites there is a need for various types of reinforcements. One of the combinations of matrix and reinforcement that has received little attention but offers great potential payoff is the metal reinforced composite. To be most effective at producing high strength as well as high toughness composites, submicron and metal powders and metal wires are required. The development of submicron diameter sperical metal powders and whiskers will enable a new class of composites to be developed. The metals to consider for development would be iron, iron nickel alloys, aluminum and molybedenum. Using the above technology fabricate appropriate parts of a steam turbine engine. After laboratory analysis, parts will be exercised on torpedo test vehicle. Parts include turbine nozzle plate and gears.

N87-53. TITLE: Field - Theoretical Model Of Acoustic Propagation With Rough Boundaries

CATEGORY: Research

DESCRIPTION: A model for the propagation of acoustic waves through a medium with rough boundaries (surface, or bottom, or both) is needed. The emphasis is on alternative approaches to conventional ray tracing techniques. A prototype test case would be one where source and receiver are under-ice and in shallow water and a low frequency acoustic wave is propagating. The output should be an analytical description of the acoustic field at the receiver for all combinations of ranges and depths. Innovative approaches to characterizing the interaction with the rough surface(s) are also appropriate.

N87-54. TITLE: Piezoelectric/Magnetostrictive Sonar Transducer

CATEGORY: Advanced Development

DESCRIPTION: An underwater sonar transducer is required which combines the advantages of a magnetostrictive and electrostrictive/piezoelectric transducer as described in U.S. Patent 4,443,731 (Butler and Clark, Hybrid Piezoelectric and Magnetostrictive Acoustic Wave Transducer). Specifically a transducer is needed which has minimal need for electrical tuning and is physically configured for pressure cancellation in the acoustic medium. Utilization of the lanthanide series magnetostrictive material Terfenol-D will optimize transducer performance.

N87-55. TITLE: Low Cost Acoustic Sensor Technology

CATEGORY: Advanced Development

DESCRIPTION: Effective deployment of acoustic detection systems will in the longer term be dependent on the development of low-cost acoustic sensor technology. Several current approaches to low-cost sensors have been based on the use of optical fibers and Polyvinyladine flouride (PVDF) wire. While these materials could potentially provide the needed low-cost acoustic sensors, laboratory investigations have revealed serious problems related to high acceleration response in the materials. Current effort to develop these sensors further are hampered by inadequate understanding of the response of such sensors to vibrational excitation. This procurement is for the development of analytical models that relate sensor output to mechanical excitation input in terms of the elastic and optical or piezcelectric properties of the sensor. With such models sensor performance might be optimized to minimize acceleration response. Sensor optimization should include not only overall sensor geometry but also optimal selection of sensor material properties. The identification of candidate sensors and laboratory evåluation of their respective vibration response is desired. Appropriate methods for mounting the candidate sensors in various types of acoustic arrays should also be considered.

N87-56. TITLE: Low Cost Telemetry System

CATEGORY: Advanced Development

DESCRIPTION: There is a need to substantially reduce the cost of current acoustic and non-acoustic data telemetry systems in arrays. These are one or two dimensional arrays with large numbers of elements, each with significant bandwidth. A telemetry system is required which can receive data from each sensor and process it to give the required information such as beam forming. Preferably each sensor will be passive or very low power and capable of a large (80 dB) dynamic range. Sensors may also be of mixed types such as acoustic and non-acoustic. The proposal shall describe the innovative, preferable non-digital, telemetry system to be used, estimate its cost and describe how the data will be processed.

N87-57. TITLE: Implementing Incremental Delays For Hydrophone Position Corrections To Fixed Delay Beamformers

CATEGORY: Advanced Development

DESCRIPTION: Current beamformers of interest assume a known and fixed hydrophone geometry. This is not always the case. An important case of interest is when the hydrophone positions are known but changing with time. Enabling a beamformer to respond to hydrophone time trajectories is a new capability. A significant problem in using this new information to compensate for beamformer degradation due to the changing geometry is the need to change the fundamental shipboard signal processing architecture. This procurement is for the development of a prototype stand-alone device which would supply incremental delays in response to array geometry changes so that the hydrophone time series, which go to the central beamformer, "appear" to be coming from undistorted geometry. This cannot be done exactly because the perturbed time delays are a function of a steered direction as well as the perturbed geometry. However, compensation within sectors of the steering space of primary interest might be possible.

N87-58. TITLE: Artic Ice Thickness Measurement

CATEGORY: Exploratory Development

DESCRIPTION: Develop a method for measurement of the thickness of arctic ice from either the surface or from under the ice using laser technology. The goal is to be able to measure the thickness of arctic ice in the range of 6 inches to 100 feet, with an accuracy of 10%.

N87-59. TITLE: Acoustic Reverberation And Background Monitoring

CATEGORY: Advanced Development

DESCRIPTION: Develop modifications to the AN/WLR-9 intercept receiver to permit real time monitoring of the reverberation and background noise fields utilizing the system's SPL (sound pressure level) measurement capability.

N87-60. TITLE: Low Frequency Underwater Sound Calibration Source

CATEGORY: Exploratory Development

DESCRIPTION: A low frequency, non-explosive, sonar projector is required to perform acoustic calibrations at sea. Specifically a highly efficient projector capable of one watt acoustic output at a mechanical resonance below 500 Hz is needed with physical dimensions such that it may be installed in a cylindrical shell with a diameter not exceeding three and one half inches and a length not to exceed 18 inches.

N87-61. TITLE: Very-Low-Frequency, High Power Sonar Projector

CATEGORY: Exploratory Development

DESCRIPTION: High power, non-explosive, broadband acoustic sources are needed to implement proposed active surveillance systems' concepts. Specifically, a flexural type sonar transducer excited electrodynamically using high efficiency magnets is required to produce a source level in the range of 190 dB to 230 dB re microPascal/Hz over the frequency range of 5 Hz to 40 Hz. To demonstrate feasibility and establish a technology base, a scaled model transducer will be initially designed and built.

N87-62. TITLE: Microbend Optical Sensor For Geartooth-Root Pressure Measurement

CATEGORY: Advanced Development

DESCRIPTION: Develop a Fiber Optical Microbend Pressure Probe for Torpedo Gear Testing. High speed gears in torpedoes are one of the major components of this noise is believed to result from the Hydrodynamic pumping action of the meshing teeth. Experimental determination of this noise sources requires the measurement of the dynamic pressure at the root. This measurment requires a very small, fast response probe with a large dynamic range. Such a device is not commercially available. An attractively simple fiber-optic pressure sensor is the microbend-attenuation device. This works by an increase in the attenuation coefficient of a multimode fiber by the imposition of millimeterscale bends, from a corrugated cover sheet. The potential advantage of this type of device include: simple signal conditioning (light amplitude measurement); easy light coupling (multimode-fiber); as well as small size, fast response and large dynamic range.

N87-63. TITLE: Acoustic Properties Of Neoprene Transducer Windows

CATEGORY: Advanced Development

DESCRIPTION: Study and test the effects of composition of neoprene such as type of carbon black used etc., on the acoustic of torpedo transducer windows. Properties to be evaluated include power absorbtion, shear, hardness, beam pattern effects etc. A neoprene having understood and controlled composition is critical to the acoustic performance of a torpedo transducer.

N87-64. TITLE: Modeling Effects Of Tribochemical Processes

CATEGORY: Exploratory Development

DESCRIPTION: Mathematical models of tribochemical processes are required to account for the chemical processes that may be critical in determining wear lifetimes, and design limits for loads and speeds. They may also be needed in determining the rate at which lubricants (or species forming the component's environment that react to produce a lubricant) must be added to reach a steady or quasisteady state that avoids lubrication distress and ensures reaching design lifetimes. Innovative approaches to the development of the database and the modeling to guide such design are required. In the first phase of this effort it is anticipated that modeling approaches will be developed and "proof-of-principle" calculations carried out. In addition concepts are to be developed for acquiring the experimental data base required to verify the models and ensure the utility of the predictions for the design engineer. Of particular interest are the following situations: (1) chemical reactions of a ceramic (or hard coated) surface with species in its environment to form a solid lubricant; (2) improving prediction of wear for metals with boundary lubrication.

N87-65. TITLE: More Effective Navigation Model For Interdiction Of Evasive Targets

CATEGORY: Exploratory Development

DESCRIPTION: Well known and widely used navigation laws (e.g., proportional, bearing rider and pursuit guidance) are not highly effective in interdiction of targets executing evasive or large volume search maneuvers, particularily if high turn rates are used. Develop and demonstrate by computer simulation a more effective navigation law to cope with such targets. Assume the target is a modern high performance torpedo, having appropriate dynamic characteristics.

N87-66. TITLE: Three Dimensional Underwater Acoustic Intensity Measurement System

CATEGORY: Advanced Development

DESCRIPTION: The objective of this SBIR is the design, fabrication and evaluation of a compact underwater acoustic measure ment system that can be used to more completely characterize the nature and sources of both radiated noise and scattered acoustic fields produced by submerged vehicles like submarines and torpedoes. A small, probe-type array of eight or more hydrophone elements is required. These elements are to be configured in such a way that the acoustic Pressure, p, and particle velocity, v, can be measured simultaneously in three orthogonal directions. Determining these two field quantities allows one to numerically compute the corresponding complex intensity ($I=pv$) and/or the complex specific acoustic impedance ($z = p/v$) at any point in the field; even

the field near the radiating or scattering surface. The sources and paths of acoustic energy can be indentified by having the probe scan the acoustic field produced by the vibrating submerged structure. The ability of the probe to simultaneously monitor the three-dimensional components of an acoustic field suggests that transient noise sources and responses can be determined. It is envisioned that the probe system will also include a separate projector element that will provide a control source for in-situ calibration and orientation of the array. Over the last few years the feasibility of a two or four element probe technique has been established for one-and two dimensional air-borne radiated noise diagnostics (e.g. 1-), however similar applications for underwater acoustic structures is relatively new (e.g. 6-8). In addition, no known system possesses the feature of the proposed system: simultaneous three-dimensional measurements, transient analysis, and in-situ calibration and orientation capabilities. A few of the technical issues needed to be addressed include the size and shape of the array, the signal processing and calibration procedures, the influence of environmental and flow noise on performance.

N87-67. TITLE: Compact Underwater Buoyancy System For Expendable Sonobuoys

CATEGORY: Engineering Development

DESCRIPTION: Design, develop, and experimentally demonstrate a compact underwater buoyancy system capable of maintaining a specified weight at any preset water depth. A desired system would require no or minimal electrical power, would be modular in applications to offset variable weights, and would be used in devices such as expendable sonobuoys. Nominal specifications include water depths of 0 - 2000 feet, undeployed/ruggedized package size: cylindrical 6" O.D. x 4" length, and having a buoyancy of 10 pounds. The use of compressed air/gases may be considered.

N87-68. TITLE: Improved Transducer Production Testing For Rubber-To-Metal Bonded Joints

CATEGORY: Advanced Development

DESCRIPTION: Improved nondestructive evaluation methods, for testing the integrity of rubber-to-metal bonds in sonar transducers is needed. Current techniques use ultrasonic, holographic, visual or mechanical methods none of which are consistently reliable and universally applicable to the numerous assortment of joint configurations found in sonar transducers. The goal of this effort is to develop a cost effective nondestructive evaluation method for testing the integrity of rubber-to-metal bonds on production units. New methods are needed which will be inexpensive, reliable and easy to use by operators having little or no training. Portability for use in field testing is also a desirable attribute. Proposed methods should be capable of detecting debonds in which the rubber and metal remain in intimate contact. In addition the methods should, as a minimum, detect debonds at corner joints and within

the annulus formed by the transducer shroud and head mass assembly.

N87-69. TITLE: Standard Backplane Busses For Navy Tactical Hardware

CATEGORY: Advanced Development

DESCRIPTION: The use of an "open architecture" (the use of a standard, well-defined backplane) for some commercial computers (e.g. the Apple IIe and IBM-PC) has enabled hundreds of thirdparty vendors to build boards for these machines and for VARs (value-added resellers) to apply these machines to a host of special applications. Furthermore, these standard-backplane processors can be easily linked via LANs (Local Area Networks) because LAN bus-access cards have been built for these standard backplanes. The Navy could more easily interconnect tactical processors, displays, etc. if they used a common standard backplane to which LANs would interface. Furthermore, the Navy could competitively procure memory boards, I/O boards CPU boards, etc. if they all worked with a standard backplane. The objective of this task is to define an innovative solution to the problem of standardization of backplanes within USN tactical computers, displays and other equipments.

N87-70. TITLE: Non-Procedural Languages For Rapid System Prototyping

CATEGORY: Advanced Development

DESCRIPTION: The successful development of large, complex computer systems depends on a detailed analysis of user needs and requirements. Errors of commission or omission during the requirements analysis phase can result in product deficiencies which can be very expensive to correct. Modern, non-procedural languages could be used to allow the rapid development of a prototype of the proposed system based on the user requirements. This prototype can provide a system model for user review and study. It will allow the early identification and correction of errors in requirements definition and help assure a better product. In addition, the prototype could serve to support automated design and development. The possible application of non-procedural languages to system prototyping will be studied with particular emphasis on problem orientation and on the consequent limitation(s) on flexibility, and an architecture for this concept developed.

N87-71. TITLE: Radar Cross Section Of Targets - Dynamic Behavior

CATEGORY: Advanced Development

DESCRIPTION: One of the major challenges facing naval weapon systems in the 1990's is to defend against attacking missiles (primarily) which have radar cross-sections considerably reduced from values regarded as typical today. The Navy deals with requirements rather simply expressed as a single value and based on first-order reflection from the vehicle itself. It is important to gain greater understanding of total cross-section (or of the "radar observables") of such targets while in flight; both the effects of the violently displaced medium and the effects of

vehicle effluents must be considered, with cause and effect separations of the two. The object is to gain an understanding of lower-bounds on radar cross-sections and, further, to develop radar waveform and signal processing methods to favor the dominant reflection mode whatever its nature. The Phase I effort requires literature search and own generation of a framework for accounting quantitatively for the several possible effects (body, medium disturbance, effluents), and some exhibit of radar characteristics likely to enhance detection (carrier frequency, resolution cell size, doppler processing), and will propose experimentation in such phenomena (as in medium-variable wind tunnels, for example) and in radar techniques appropriate (whether at own facility or in cooperation with others, government or industry) for Phase II accomplishment.

N87-72. TITLE: Use Of Millimeter Wave Technology In Naval Shipborne Radar Applications

CATEGORY: Advanced Development

DESCRIPTION: Among the many challenges facing radars in the 1990's in their support of shipboard weaponry are some in which the characteristics normally associated with millimeter wave radar would seem well-suited to meet. For example, wavelengths of 10mm and shorter permit quite narrow beams from modestly sized antennas; this permits in turn low elevation tracking in the presence of multipath (sea surface reflection), less off-set jamming, interference and clutter sources. Other generally accepted challenges in naval radar are the smaller-cross-section targets, one's own desire to hide one's signal, the desire to classify targets by high-resolution (multi-dimensional) signals and processing, and exploitation of the particular propagation characteristics of the medium. The use of millimeter wave radar is not itself unknown in the free-world military. The object of this work is to associate the 1990's needs of shipborne radar with the properties of millimeter wave radar (particularly as seen in maturing systems elsewhere), and to present (relative to U.S. Navy's present and projected radar systems) complementary features, subsystems or companion systems that could become parts of our improved systems or new developments of the early 1990's. A Phase I report will require review of these requirements, of our present systems and plans, of millimeter state of the art and equipment availability, the accomplishment of some performance and sizing calculations, and recommendations for Phase II pursuit involving experimentation and demonstration.

N87-73. TITLE: Critical Strain Energy Density As A Fracture Mechanics Criterion

CATEGORY: Advanced Development

DESCRIPTION: For elastic-plastic fracture of ductile metals, several fracture mechanics criteria have been proposed. One of these, the method of critical strain energy density has the advantage of being able to evaluate the non-linear case of mixed-mode elastic-plastic fracture.

An arguement for this method is that the critical strain energy density can be determined from a true stress-strain test, and other fracture tests are unnecessary. This initiative is intended to evaluate that hypothesis. Comparison of various steels, including Ordinary Strength (OS), Higher Strength (HS), HSLA-80 and HY-80 alloys will be made to establish a correlation between the strain energy determined from a true stress-strain tensile test and fracture evaluated by other parameters, including J_{1c} and Charpy V-notch.

N87-74. TITLE: Computer Program To Predict Fatigue Crack Growth

CATEGORY: Advanced Development

DESCRIPTION: The objective is to identify existing fatigue crack growth computer programs which can accurately predict growth in submarine hull structural details. The lack of analytical methods to predict fatigue crack growth in submarine hull structures have lead to a reliance on large scale model tests when developing and certifying new hull materials and suspected overly conservative surveillance procedures. A validated analytical method would provide a tool for assessing current surveillance procedures and possibly eliminate the need for large scale fatigue model tests. This effort will consist of surveying existing programs and selecting those surface discontinuities in structures subjected to variable amplitude applied compressive loading and residual welding stresses. The selected programs will then be used to analyze a number benchmark experimental cases to determine each programs accuracy.

N87-75. TITLE: Composites For Auxiliary Machinery Components And Equipment

CATEGORY: Advanced Development

DESCRIPTION: Composites offer potential advantages which are not only limited to initial cost and weight savings but also include corrosion resistance, design adaptability and multifunctionality which will reduce acquisition and maintenance costs of future Naval machinery components. Weight savings of at least 20-30% can be realized by replacing metals with FRP's in machinery-related applications such as: (1) shafts, (2) intake ducting, and (3) housings for electrical systems (e.g., generators, motor housings, panels, enclosures). Where required, a hybrid concept can be utilized; e.g., a composite shell containing an insulated high-temperature metallic liner for application for exhaust ducts. In addition, in applications where corrosion resistance, as well as weight reduction is of concern (e.g., fuel, sanitary and ballast tanks), FRP's provide an attractive alternate to metal for areas that have historically been difficult to preserve due to near-impossible surface preparation/access situations. Composite selection, fabrication techniques and property characterization compatible with application, should be addressed. Issues such as fire, smoke & toxicity must be considered.

N87-76. TITLE: Detection Of Antifoulants In Aqueous Media

CATEGORY: Advanced Development

DESCRIPTION: Anti-fouling paints for boats and ships are designed to release toxins onto the surrounding seawater to hinder the adherence and growth of bacteria, diatoms and slime films on the hull. These films are believed to increase the hydrodynamic drag factor, and adhering mollusk and arthropods can actually damage the paint film on the ship. Tributyltin compounds have been demonstrated to be very effective biocides. Novel analytical methods to detect and determine the concentration of parent biocide and related oxidation or degradation products are sought to better evaluate the risks, if any, to nontarget organisms.

N87-77. TITLE: <u>Fire Resistant Barriers For Composites</u>

CATEGRY: Advanced Development

DESCRIPTION: Various studies have shown that demands to reduce weight and improve specific structural characteristics of Naval Ships can often be met through the use of organic matrix composites. However, one major obstacle remaining in the way, which limits use of composites on Naval ships is the combustible nature of the polymeric component of the composite. A potential solution is the use of fire resistant barriers for composites. This barrier can be an outer skin of a composite, either mechanically bonded or integrally fabricated to the polymeric material. Metallic or ceramic materials may be considered. However, such barriers must have minimal weight impact and be able to be conformal to a variety of geometrics. Methods of attachment will need to be addressed as well as fire performance of the barrier material including effect on composite properties after fire testing.

N87-78. TITLE: <u>Noise Control Bibliography</u>

CATEGORY: Management Support

DESCRIPTION: Develop an annotated bibliography of open noise control literature according to topics such as:

Machinery quieting
Measurement and analysis techniques
Acoustical materials
Effects of noise on people

Sources to be used should include references to contemporary papers in Acoustics (supplement to Journal of Acoustical Society of America), Engineering Index, Applied Sciences & Technology Index, and Reader's Guide to Periodical Literature.

Bibliography should begin in 1975.

Bibliography should include brief (50 words or less) snyopsis of indexed literature.

N87-79. TITLE: Flowmeter Technology

CATEGORY: Exploratory Development

DESCRIPTION: New flowmeter technology is required to accurately measure the mass of fuel transferred during open sea re-fueling operations. Flow rates in excess of 1000 gallons per minute are required with desired accuracies of 1%. This investigation should evaluate the available technology and determine the feasibility of new flowmeter technologies. The flowmeter must function under extreme environmental conditions and present no explosion hazard.

N87-80. TITLE: Miniaturized Magnetic Sensor

CATEGORY: Exploratory Development

DESCRIPTION: Show feasibility for developing a miniature single axis magnetic sensor capable of detecting field changes in 1 nanotesla in a background field of 20 oersteds, with a bandwidth of DC to 100 Hz. The sensor shall operate at room temperature with a stability and drift of 1 nanotesla per hour. The sensor element shall not be more than 10 cm^2 in volume (not including electronics).

N87-81. TITLE: Improved Fracture Resistance Of Gas Turbine Ceramics

CATEGORY: Research

DESCRIPTION: Basic investigation into the fracture initiation of ceramics could provide useful information needed to extend the life of ceramics in gas turbine engines. This effort should determine if it is the presence of latent flaws or impurities which initiate cracks in ceramics and identify the nature of those flaws if possible. Almost any representative ceramic can be used provided it has application in the gas turbine engine hot section. The effort would involve identifying a material, obtaining samples initiating fractures in such a way that the fracture surfaces can be studied to determine the source of the fracture initiation and writing a report.

N87-82. TITLE: Ceramic Structures For Diesel Engines

CATEGORY: Advanced Development

DESCRIPTION: A significant problem in the application of ceramic materials to diesel engines concerns integrity of ceramic to metal structures. Cylinder liners and heads, valves and pistons might display increased life, lower friction, and better engine performance if a reliable method of joining were available. The disparity in thermal coefficients of expansion is a principal problem. Composites of ceramics and metals, and fabrication methods to reduce their disparity should be investigated. Test pieces should be joined and thermal cycled under simulated conditions, and a report made comparing present techniques to test samples reflected.

N87-83. TITLE: Development Of Low Cost RPV Sensor And Communications Payloads

CATEGORY: Advanced Development

DESCRIPTION: Conduct development and test of low cost sensor and communication payloads for expendable Remote Piloted Vehicles (RPV's) for over the Horizon (OTH) targeting and reconnaissance roles. The feasibility of launch and retrieval is being developed in current R&D programs, however, the amount of R&D being accomplished for RPV payloads is limited. Without payload development, RPV applications to the Navy's Surface Ship Continuing Concept Formulation (CONFORM) Programs ship designs are not credible.

N87-84. TITLE: Millimeter Radar Non-Contact Ranging

CATEGORY: Advanced Development

DESCRIPTION: Simple and effective non-contact ranging sensors are needed for use on mobile robotic platforms for purposes of obstacle avoidance, vehicle navigation, and discrete object detection. Conventional radar systems have been used since World War II to determine range to targets and other objects, but are traditionally complex, expensive, and lack the resolution needed for the short range applications required of robotic systems. Millimeter wave radar may provide a cost-effective solution as a non-contact ranging sensor for mobile robots. Proposals should stress low cost, low power consumption, and should quantify the expected range and bearing resolution of the resultant system.

N87-85. TITLE: Ship Motion Effects

CATEGORY: Exploratory Development

DESCRIPTION: Throughout history the environment aboard ship has presented a challenge to those designing equipment which must function in concert with the pitch, roll and yaw of a vessel at sea. Numerous potential shipboard robotic systems are being studied in attempts to improve safety, increase productivity, and reduce manning. This effort requires the investigation of effects of ship motion on robot dynamics and equipment life, and to develop specific solutions to any such identified problems so as to minimize performance and service life degradation.

N87-86. TITLE: Torpedo MK 48 Adcap Thermal Battery

CATEGORY: Engineering Development

DESCRIPTION: The Torpedo MK 48 ADCAP utilizes a thermal battery to provide electrical power to the torpedo during its transition from external power to load assumption by the internal torpedo alternator. This battery is functional between the application of the fire signal

and the time when the torpedo alternator assumes all internal loads (approximately 10 seconds). Once activated the battery load life is ten seconds. Once the firing key has been closed the thermal battery must be considered activated. If a misfire occurs the torpedo must be considered a dud weapon and backhauled for thermal battery replacement. An alternate transition power supply is therefore required that will allow more than one firing attempt for the weapon. The alternate must be of the same form, fit and function as the existing thermal battery.

N87-87. TITLE: Advanced Power Sources For Naval Mines

CATEGORY: Advanced Development

DESCRIPTION: Power/energy dense, safe batteries with long shelf lives are required for Naval mines. This effort seeks to develop a new mine battery to meet these demanding requirements that is also economical to produce.

N87-88. TITLE: Naval Minefield Computer Modeling

CATEGORY: Advanced Development

DESCRIPTION: Computers are used to simulate the behavior of Naval mines and minefields. The results of these simulations are used to set inventory objectives or to determine which characteristics of Naval mines need improvement. New modeling methods are needed to refine estimates of minefield performance with varying targets and countermeasures.

N87-89. TITLE: Rapid Mine Surveillance In Shallow Water

CATEGORY: Advanced Development

DESCRIPTION: Surface forces can not conduct over-the-beach operations through mined shallow water. Mine clearance in shallow water is very difficult. One means of reducing the threat from mines would be to be able to survey a hostile coastal area rapidly for mines and then select for the operations an area where there was a low density of mines. This effort seeks to identify and verify the type of sensors which could be used to rapidly locate submerged and partially buried mines in coastal environments to depths of 30 feet or more. The rate of coverage needed is such that an aircraft platform would be required for the sensor.

N87-90. TITLE: Voice Actuated/Phonetic Recognition Microcomputer Input Device

CATEGORY: Advanced Development

DESCRIPTION: The Navy requires a small device with the ability to translate voice input into data which can be read by a computer. It is needed for many inquiry-driven, transaction-oriented applications. A vocal phonetic recognition device could be used to augment bar code reading devices or other forms of source data automation technology

already planned or in existence. The device must be able to translate enough phonetic characters to be equivalent to at least 50 spoken numbers, alphabetic letters, and control words, i.e., dot, dash, commas, etc. The device must provide some type of feedback, either audible or visual to the user so that translation can be verified and confidence in translating abilities can be established. The performance of the device must not be affected by background noise associated with shipboard and/or warehouse operation. Finally, the device must be capable of being programmed to format translated data, must be compatible with a variety of common protocols, and be able to connect via RS-232 type interface ports with a large range of microcomputer hardware and mainframe peripheral devices.

N87-91. TITLE: Electric Power Supply And Pump-Motor Assembly

CATEGORY: Advanced Development

DESCRIPTION: A compact, efficient, electric power supply and pump-motor assembly is required to provide chilled water to a portable personal cooling system. The power supply should be low voltage, 12V or 24V, and provide sufficient power to the pump-motor assembly to allow for 6 hours of operation. Recharging of the power supply should be easily and rapidly attained using a standard 115V AC source. The pump should be designed to provide approximately 200 lbs/hr flow of water at 20 psig. Minimization of size and weight are primary considerations for both the power supply and pump-motor assembly. The power supply shall be capable of being recharged at least 100 cycles.

N87-92. TITLE: Flame Retardant Coated Fabric For Hazardous Chemical Handler's Protective Clothing

CATEGORY: Advanced Development

DESCRIPTION: The Navy has a need for a liquid/vapor impermeable, flame retardant material for use in the manufacture of hazardous chemical handler's protective clothing. Desired properties include self-extinguishing, no melt-drip, impermeable to all known hazardous chemicals (liquid and vapor form), unaffected by all classes of petroleum oil and lubricating products, flexible at temperatures from -40^{o}F to 120^{o}F, and possess a tear strength of 8 lbs. (min) warp and filling.

N87-93. TITLE: Alternative Buoyant, Flame Retardant Materials For Clothing Applications

CATEGORY: Advanced Development

DESCRIPTION: The Navy has a need for fire retardant buoyant insulating materials other than closed cell foams for use in cold weather clothing. The materials should be self-extinguishing upon exposure to flame, hydrophobic when submerged in water and have the potential to be incorporated into a garment to provide insulation and positive buoyancy, while still providing some degree of air permeability.

N87-94. TITLE: Telemetry System For Measurement Of Body Temperatures

CATEGORY: Advanced Development

DESCRIPTION: A need exists for an untethered, compact, portable telemetry system for measurement of body temperatures, including both skin and core temperatures. The system should be capable of telemetering temperatures for a distance of up to one-quarter mile in an unobstructed area. It should be portable and adaptable for both field and laboratory use and should be capable of use onboard Navy vessels and underwater. The transmitter should be lightweight, as it would be carried on the person. The receiver should be portable but will be located in a fixed area. As a minimum, the system should be capable of measuring three skin sites and one core site simultaneously. Preferably, core temperature should be measured internally in a location other than the rectum. However, the selected site should show good correlation with measurement of esophageal or rectal temperature. The range for the core temperature measurements should be 33-40°C; for the skin temperature measurement, 9-40°C. The digital readout should be accurate to 0.1°C.

N87-95. TITLE: Standard Generalized Markup Language (SGML) Integrated Software Package

CATEGORY: Advanced Development

DESCRIPTION: The Navy requires a Standard Generalized Markup Language (SGML) Parser. It will enable automated printing and publishing of electronical composed documents received via telecommunications. Current commercial automated publishing systems are unsuitable because they are geared to an in-house environment and would necessitate rekeying of data received electronically from the multitude of word processors used through out Navy. The Navy Publication and Printing Service Management Office (NPPSMO) already has contracted for the selection of a small subset of SGML tags and supporting document type definitions to utilize gencodes for manual coding by the publishing customer. It is expected this language will serve as a preliminary publishing guideline with evolution to content tagging since SGML's use has recently been approved by the International Standards Organization (ISO). As an innovative enhancement to NPPSMO's initial gencode tagging, this project will develop an integrated package of software to eliminate manual insertion codes for existing documents. The software is to automatically invoke a syntax-directed editor for new documents and validate the SGML tags and document type definitions through a parser. There should be a loose coupling between the various components of the integrated software with any hardware or vendor software. Total decoupling between the syntax-directed editor and the automated program to tag existing documents are required. The integrated package should be developed in "C", be designed to operate on micro- and mini-based computer systems with interface capability to various hardware format processors, handle a wide variety of document formats, and comply with ANSI standard X3.64-1979, subj: "Additional Controls for Use with American National Standard Code for Information Interchange" (FIPS PUB

86). The validating parser shall have the capability to detect whether a document is correct or incorrect according to the rules of SGML and the associated document type definitions, and should be able to output fully qualified generic identifiers as well as a fully tagged document (removing minimization).

N87-96. TITLE: Non-Metallic (Self Curing) Toe Protection For Footwear

CATEGORY: Engineering Development

DESCRIPTION: The Navy requires a light, self-curing compression resistant, safety toe box capable of resisting a compression force in excess of 2500 pounds and an impact of 75 foot pounds as per ANSI Z41.1 1983 standard. This non-metallic toe would replace the prevailing steel safety toe which is the standard of the footwear industry.

N87-97. TITLE: Miniature Transducers For Measuring Respiratory Rate, Volume, And Oxygen And Carbon Dioxide Concentration

CATEGORY: Engineering Development

DESCRIPTION: The development of miniature transducers, compatible with a naval aviator's oxygen mask, to measure respiratory rate, volume, and oxygen and carbon dioxide concentration with sufficient response time to calculate uptake (VO2) and production (VCO2) during flight is essential for quantifying metabolic work during various flight maneuvers in operational environments. The Naval Aerospace Medical Research Laboratory (NAMRL) is soon to acquire a solid-state recording device that is capable of recording numerous physiological and environmental parameters during flight. Any transducers used in conjunction with this device must be able to convert Physiological readings into analog signals that can be automatically recorded on a solid-state device. Oxygen and carbon dioxide transducers that are small enough to fit inside an oxygen mask and are not affected by environmental extremes (e.g., G-forces, barometric pressure changes, and vibration) are not currently available.

N87-98. TITLE: Observability Of Rotorcraft Due To Electrostatic Charging

CATEGORY: Exploratory Development

DESCRIPTION: Evaluate the susceptibility of rotorcraft to detection, tracking and targeting by enemy forces resulting from buildup of electrostatic charge on the aircraft. Determine variation in susceptibility with ground plane characteristics, atmospheric characteristics, and conditions controllable by the crew (such as altitude, airspeed, etc.). This effort will be pursued with a view to possible follow-on work in these areas: Explore possible means of countering any significant susceptibility discovered; Evaluate threat to other types of aircraft and applicability of countermeasures; Explore exploitability of the effects for own force observation of enemy aircraft.

N87-99. TITLE: Development Of Innovative Computer Applications For Navy Aircraft/Ship Interface Equipment

CATEGORY: Management and Support

DESCRIPTION: Develop innovative approaches and new techniques utilizing installed hardware and software for logistical, budgetary, and program management applications in the area of navy shipboard and shore-based launch and recovery, and aircraft interface equipment. Desired is a relational data base management system able to communicate via 2400 baud modem in a wide-area remote network linking diverse Navy Agencies utilizing current knowledge gained form informational systems applied/expert technology areas. Specifically, support is required for equipment ILS effort, government furnished property inventory management, engineering change proposal and ship alteration material tracking, internal and external budgetary spreadsheets and documents, and generation of applicable reports. Consideration must be given to internal data control, electronic mail and quality assurances issues. Generic to this effort will be the conducting of a requirements definition analysis/study, development of a master/overview plan, concept feasibility demonstration through the development and building of a working software prototype and supporting technical documentation. Project objective would be to achieve more effective cost control, enchance the quality of inventory management and tracking, and improve the accuracy of long range planning. Additionally, a data repository will be established from which information and knowledge can be organized to assist management in making more timely and accurate decisions.

N87-100. TITLE: Knowledge Base For Fault Symptom Relationship In Helicopters

CATEGORY: Exploratory Development

DESCRIPTION: Develop structural relationships between failure modes and observable symptoms for use in real-time monitoring of helicopter propulsion system components and airframes. Current knowledge includes a number of one-to-one relationships such as 1/rev vibration caused by tail rotor drive shaft unbalance, but does not adequately address other, less-common signals such as two-per-rev, gear rotational sideboards, etc., which are thought to accompany early failure conditions.

N87-101. TITLE: On-Board Real-Time Monitoring Of Helicopter Condition

CATEGORY: Advanced Development

DESCRIPTION: Existing helicopter propulsion system vibration monitoring techniques involve measurement of a few single-point readings, usually on the ground. Advanced aircraft now employ considerable on-board computer power, some of which might be applied to intermittent acquisition of key vibration signal components, and a comprehensive analysis of these signals to determine changes in propulsion system condition. Required is an analysis of the practicality

of utilizing on-board computers for the purpose of housing expert systems having considerable inherent understanding of the propulsion components.

N87-102. TITLE: Automated Ultrasonic Scan Data Formatting And Storage

CATEGORY: Advanced Development

DESCRIPTION: Develop software and hardware to provide compatibility among all computer base large area automated ultrasonic scanning equipment within DOD and DOD contractors. This software will format and store automated ultrasonic data on multitrack magnetic tape or other appropriate medium. A hardware and software specification for incorporation into all future RFQs and weapons systems contracts which require automated ultrasonic scan inspections will be written. This specification will also identify appropriate retrofit measures to bring existing DOD and DOD contractors automated ultrasonic equipment into conformance. This specification will require compatibility among DOD and DOD contractors facilities, thus allowing transfer of automated ultrasonic scan data.

N87-103. TITLE: VHSIC Technology Introduction

CATEGORY: Exploratory Development

DESCRIPTION: Identify, describe, and examine a range of potential VHSIC technology applications for Combat Identification System (CIS) programs. This study should present the expected technical and manufacturing risks and benefits associated with each application. Additionally a plan of action and milestones will be developed for each potential application to facilitate informed management action. This effort will enable the CIS programs to identify and characterize significant benefits and risk areas associated with this emerging technology.

N87-104. TITLE: Fiber Optic Crossbar Switches

CATEGORY: Advanced Development

DESCRIPTION: Techniques and devices for multiple (n x u) part crossbar switching of optical communications signals are required. Rapid switching and full duplex operation are requirements as well as the ability to meet severe military environments.

N87-105. TITLE: Artificial Intelligence Processing Capability

CATEGORY: Advanced Development

DESCRIPTION: Develop an artificial intelligence signal integration technique which improves target classification capabilities using data provided by outputs from "ARTIS", "OPUS" MK XV and infrared sensor sources. The objective is to fuse sensor data in such a manner that a target can be classified quickly and accurately when a minimum of data

from sensors is arrayed against known target characteristics.

N87-106. TITLE: EHF Flush Mounted Conformal Array For Aircraft Command & Communication Systems

CATEGORY: Exploratory Development

DESCRIPTION: Conduct a feasibility study of a dual frequency millimeter band conformal array antenna system to provide in excess of upper hemispherical coverage from an aircraft platform to a satellite. The array must be capable of transmitting greater than 100W at 44GHz and receiving at 20GHz. It shall provide at least 40 d.B.I. gain in both bands and be circularly polarized. Bandwidth is less than five percent of the transmitted or receiver frequency. The array must be steerable and must be capable of locking on to a received signal from a satellite.

N87-107. TITLE: Trailing Wire Antenna Icing

CATEGORY: Exploratory Development

DESCRIPTION: Develop description and modeling of icing buildup on thin (.16 inch diameter) wire of long (20,000 ft) length deployed from slow moving aircraft. The objectives are to: Provide predictions on tension and ice buildup for various weather conditions and provide recommendations on methods to protect the antenna from ice buildup. The slow moving aircraft is defined as 170-180 knots true airspeed maneuvering in continuous 30 degree angle of bank turn. Consideration should be given where the aircraft is in straight and level flight also. Altitude of the aircraft is assumed to be 17,000 to 27,000 feet.

N87-108. TITLE: High Conductivity Electrical Cables With Improved Cooling

CATEGORY: Advanced Development

DESCRIPTION: A need exists for electrical cables which can conduct high currents without excessive heat build-up. Existing cable designs use metallic conductors (aluminum, copper) which overheat before the system reaches its' maximum potential. Advanced composite materials may show an advantage for this application. Design concepts must emphasize high current densities and an insulation approach that will permit open ocean use.

N87-109. TITLE: Real-Time Radar Techniques For Electronic Countermeasures Signal Discrimination

CATEGORY: Advanced Development

DESCRIPTION: Complex ECM (Electronic Countermeasures) environments are effective against Radar systems with conventional ECM signal detection and recognition techniques. The basic purpose of this effort will be to develop a single pulse Radar ECCM (Electronic Counter-Countermeasures)

technique to discriminate ECM deception and transponder signals from target returns. The system analysis should include basic Radar ECCM system concept development, theoretical analysis, effectiveness against generic ECM repeater techniques, and effectiveness against ECM transponder techniques. Also, the expected tactical performance payoffs for U.S. Navy applications should be considered.

N87-110. TITLE: Theoretical Characterization Of Radar Traveling Wave Tube Amplifier Modulation-On-Pulse Signatures

CATEGORY: Exploratory Development

DESCRIPTION: Pulsed waveforms have modulation-on-pulse (MOP) signatures, which may be useful information sources for advanced Electronic Warfare systems. These MOP signature may be utilized for Electronic Support Measures classification and identification purposes. Theoretical analysis and quantification of MOP signatures for modern radar systems has been completed. The objective of this work is to perform theoretical MOP analysis of pulsed radar systems employing TWT amplifiers. MOP signatures will be theoretically quantified with source mechanisms and potential use in advanced EW systems from theoretical and real-world perspectives.

N87-111. TITLE: Reliability Testing Of Sealed Electronic Component Packages

CATEGORY: Engineering Development

DESCRIPTION: An optical correlation method has been developed to test the integrity of sealed microelectronic packages on a one by one basis. This new method is based on an optical correlation technique using a low-power laser. The only substantial problem remaining to produce a viable work station version is packaging. Additional design is needed to produce a batch testing version. The extension of the method to determine leak location and the nature of the leak is feasible with further study. The method is described in the article "Detecting Non-uniformity in Small Weld and Solder Seams using Optical Correlation and Electronic Processing" in Applied Optics, (Vol. 20, p. 3605), 15 Oct 1981.

N87-112. TITLE: Passive Non-Cooperative Target Recognition (PNCTR)

CATEGORY: Advanced Development

DESCRIPTION: Analyze and define the role and requirements for PNCTR and associated Technologies in the support of Combat Identification Systems Development. The analysis is to include allocation of PNCTR capabilities in combination with Q & A, and active NCTR in the Combat Identification System (CIS) Architecture. Define the role of PNCTR in providing classifications and confidence levels which will permit

changes in the rules of engagement based in the CIS at the platform level. Examine the available technologies, their degree of application and associated risks. Include projected time frame in which a mature capability can be achieved at the platform level.

N87-113. TITLE: Infrared Clutter Rejection Signal Processing

CATEGORY: Advanced Development

DESCRIPTION: Investigate algorithms and clutter rejection signal processing to improve clutter rejection performance in Infrared Search and Track Sets (IRSTs).

N87-114. TITLE: Multi-Wave Band IR Focal Plane Arrays

CATEGORY: Exploratory Development

DESCRIPTION: Investigate the feasibility of fabricating Infrared Focal Plane Arrays (FPA's) through use of materials, structures, cryogenic temperature or other design features that are usable over multiple wave length bands. The bands of interest are between 2-14 micrometers or subsets thereof.

N87-115. TITLE: Radar And Electronic Warfare Systems Information Sharing And Power Management

CATEGORY: Advanced Development

DESCRIPTION: Investigate the possibilities of sharing information between airborne radar and Electronic Warfare (EW) Systems aboard an aircraft for the purpose of target identification and targeting. Investigate radar and EW power management techniques.

N87-116. TITLE: Corrosion Protective Marine Paint Systems

CATEGORY: Advanced Development

DESCRIPTION: Corrosion protective marine Paint systems are needed that are compatible with Volatile Organic Compound (VOC) emission regulations* and air quality standards* for FBM applications. *(e.g. San Francisco Bay Area Air Quality Board) New state, local, etc. environmental regulations/standards will prevent the use of many existing marine paint systems presently applicable for FBM equipment. Replacement systems are needed.

N87-117. TITLE: New Corrosion Evaluation Techniques (Electrochemical)

CATEGORY: Advanced Development

DESCRIPTION: Requirements for corrosion testing include long term immersion tests. If a proven correlation between the electrochemical behavior, and long term immersion behavior can be found for particular

materials (e.g. ferralium), then the long term tests maybe replaced by quick polarization measurements.

N87-118. TITLE: Methods Of Relating Dynamic Elastomer Properties To Lab Scale Tests

CATEGORY: Advanced Development

DESCRIPTION: A correlation method to compare the dynamic characteristics of "Engineered Elastomers" (e.g. shock pads, launch seals) to simple laboratory scale tests such as - dynamic mechanical analyzer, Rheometrics analyzer, etc. - is needed. Such correlation technique could provide valuable data for use in dynamic math models of the "Engineered Elastomer." Successful analytical tools - math model - would greatly lessen the time and expenses associated with the iterative design technique presently used.

N87-119. TITLE: Advanced Surface Cladding Of Metals

CATEGORY: Advanced Development

DESCRIPTION: Develop laser cladding methods for titanium and turbine blade alloys. Use a variety of properly selected cladding materials based on wear resistance and corrosion improvement. Analyze for dilution and chemistry. Perform wear tests and environmental resistance evaluation.

N87-120. TITLE: Development Of Metallic Surfaces With A Very High Light Absorption Capability

CATEGORY: Advanced Development

DESCRIPTION: Stellar inertial guidance requires star images to be detected with a high probability of acquisition. Stray light reflected from the sunshield or other surfaces in the light path to the detector creates background noise which reduces the signal to noise ratio and hence the probability of acquisition. There is a need for the development of a new, very non-reflective and very durable surface which will not allow stray light from the sun, moon, earth, or plume to scatter off its surface into the stellar detector.

N87-121. TITLE: Improved Inspection Techniques

CATEGORY: Advanced Development

DESCRIPTION: High Z metallic material is a spray deposited on the inside of guidance Packages for some design applications. It is important for these applications that the coating be continuous and without holes. Inspection of this process is slow and cumbersome by conventional techniques to insure a reliable product. It would be of great assistance to the guidance manufacturer if a rapid, reliable inspection technique could be developed. It is generally desired to detect holes

on the order of .001" diameter.

N87-122. TITLE: Evaluation Of Functions Represented By Grid Points

CATEGORY: Advanced Development

DESCRIPTION: A future guidance system might have to derive gravity from a set of values stored on a three dimensional grid of points around the trajectory. The optimum approach requires a tradeoff between the interrolation function, the number and regularity of the grid points, the computer filing system, speed, and memory. Another guidance application would be the derivation of a map in map matching guidance. What is desired is a generalized algorithm and associated techniques which would allow specialization of the algorithm for a particular application to yield an efficient computer program.

N87-123. TITLE: Reduction Of Consolidation Stresses In Ceramic Reinforced Metal Matrix Composites

CATEGORY: Exploratory Development

DESCRIPTION: Metal matrix composites exhibit consolidation stresses as the metal matrix and ceramic reinforcement are allowed to cool to room temperature from the elevated formation temperature (near the matrix liquidus). There is concern for how this room temperature (or equipment usage temperature) stress condition will affect micro-creep behavior of the composite. Questions that need answering include:

(a) Is there some acceptable or even desirable level of residual stress in the matrix?;

(b) Are there techniques (Plastic yielding for example that can be used to modify the amount of residual stress in the matrix?; and

(c) Can predictive schemes be developed to accurately Predict residual stress levels in metal matrix composite systems of interest?.

N87-124. TITLE: Graphite Reinforced Magnesium As An Alumina Matching Low Coefficient Of Thermal Expansion (CTE) Material

CATEGORY: Exploratory Development

DESCRIPTION: Commercial 6061 is commonly used as the support structure material for alumina chip carriers in many electronic packaging designs. The bond between the aluminum (CTE=13 ppm/degrees F) and the alumina (CTE=3 ppm/degrees F) requires a carefully designed adhesive lap shear joint. A metal matrix composite (magnesium with graphite reinforcement) has been suggested as a solution to the aluminum-alumina bond problem. Depending on the volume fraction of graphite used (25 to 40 volume percent) the composite CTE is predicted to be from about 6 to 3

ppm/degrees F. Additionally the composite density will only be about 67% of aluminum. The graphite is expected to make machining possible with conventional tools. The objective of this effort would be to demonstrate the fabrication of one or more volume fractions of this material and to get experimental data on CTE, density, strength and machineability.

N87-125. TITLE: Hard Real Time Software Design Methodology

CATEGORY: Engineering Development

DESCRIPTION: Current practice in designing hard real-time systems leave little provision for guaranteeing stringent timing specifications will be met. These software development concepts are not suitable for systems which must function in the hard real-time environment. The objective of this effect is to develop a methodology which is a basis for mechanizing the design and maintenance of software which operates in the hard real-time environment.

N87-126. TITLE: Diagnostic Test Methodology For Large Real Time System

CATEGORY: Engineering Development

DESCRIPTION: Review state-of-the-art methodologies for automated development of diagnostic test cases. Distributed systems present a difficult problem to the diagnostics designer which may be best solved through an automated methodology. Proposals are invited which address equipment and/or system diagnostic applications for both on-line and off-line diagnostics.

N87-127. TITLE: Pascal To ADA Cross Compiler

CATEGORY: Engineering Development

DESCRIPTION: Investigate feasibility of and define constraints and limitations for development of a software system to translate PASCAL programs to ADA. The Compiler will be capable of generating code for two unique target computers, one for software development; the other for tactical military deployment.

N87-128. TITLE: Real Time Software Requirements Automation

CATEGORY: Engineering Development

DESCRIPTION: Software revisions to operational systems must be made to react to changes in system requirements. This on-going maintenance effort accounts for an ever increasing portion of the system's life cycle cost. Cost reductions and increased accuracy have been realized when automated requirement methodologies have been applied to new developments; similar savings may be realized for maintenance of existing systems. Investigate and report on feasibility of utilizing an

automated requirements development tool to translate existing computer software requirements into an automated form. This effort will determine the cost/benefit tradeoff of automating existing software requirements in order to reduce the ever-increasing life-cycle cost of maintaining operational systems. Proposals should address: (a) methodologies available for automating software requirements; (b) implementation of a specific methodology, and (c) cost/benefit analysis of maintenance dollars saved to methodology cost.

N87-129. TITLE: Characterization Studies Of High Energy Density Batteries

CATEGORY: Advanced Development

DESCRIPTION: Conduct characterization studies of advanced electrochemical systems such as lithium/poly-carbon monofluoride for application in long-life deep ocean devices. The chemistry should be elucidated in terms of safe applications and deployment from submarine, aircraft and surface ship platforms.

N87-130. TITLE: Infrared Sea Background Modeling And Model Validation

CATEGORY: Exploratory Development

DESCRIPTION: The prediction of Navy Electro-optic Infrared System Performance is hampered by the lack of accurate models which Predict infrared sea background radiance (3- 5μm and 8-12μm). Models currently exist (e.g. LOWTRAN) which predict downwelling sky radiance but these must be combined with a complimentary model which predicts how the sea surface reflects the sky radiance. A unified model combining existing sky radiance models with a sea surface reflectance prediction in terms of weather and sea conditions is sought. A plan to validate the model experimentally in Phase II is required. Equipment necessary to obtain data may be obtained commercially or designed using commercial components.

N87-131. TITLE: Multi-Color Infrared Sensor Linear Arrays

CATEGORY: Exploratory Development

DESCRIPTION: A need exists in a variety of military applications for low cost, multicolor, infrared sensor linear arrays. Proposals to produce photovoltaic, backside illuminated arrays using epitaxial PbS_xSe_{1-x} grown on BaF_2 substrates will be considered. These arrays should be based on Schottky barrier devices, and should take advantage of the insulating nature of the BaF_2 substrate for possible multilayer metallization and interconnect structures. Initial objectives should include the fabrication of a 64 element two-color array, 32 elements of each color, with 10 mil center to center spacing. All 64 elements should be in line, not staggered, and the colors (A and B) should alternate along the line, ABABA.... Longer range objectives should include three and four color linear photovoltaic arrays and appropriate read out

schemes.

N87-132. TITLE: Precision Optical Tracking For Short Range Engagement

CATEGORY: Advanced Development

DESCRIPTION: Electro-optical Systems have been proposed as adjunct sensors for radar-based fire control systems. The electro-optical systems should provide increased tracking capability in multipath, jamming and low observable conditions. This project is to develop and demonstrate a prototype system that will be useful in the surface local area defense role. The prototype system will use infrared thermal sensors and automatic video acquisition and tracking systems.

N87-133. TITLE: Infrared Transmissometer

CATEGORY: Advanced Development

DESCRIPTION: Infrared systems such as optical trackers, seekers and fuzes are limited by optical transmission through the atmosphere. This project is to develop and demonstrate a low cost infrared transmissometer. The transmissometer should cover the optical band from one micron to 14 microns. Algorithm which correlates weather data such as sea state, wind, rain, humidity, and temperature shall also be developed.

N87-134. TITLE: Long Haul Fiber Optic Link For Navy Ranges

CATEGORY: Advanced Development

DESCRIPTION: Long haul, point-to-point fiber optic communication is being applied to various communication needs. A prototype fiber link is needed to provide a digital data path for remote in-water data gathering. Under this project, one or more models will be developed to establish cost effective performance standards for Navy Ranges. These performance standards will include delivery of power to the in-water systems, maximum data rates, and reliability. Present (and planned) systems will be taken into account. The model(s) will permit specific features to be studied in detail. A small scale prototype will be built and tested.

N87-135. TITLE: Non-Destructive Testing By Imaging With Penetrating Radiation

CATEGORY: Advanced Development

DESCRIPTION: A need exists to develop a large area high resolution sensor with diameters in the range of 20 to 25 inches, which provides a video type signal output and is able to perform in a snap-shot mode of operation. Exposure and read-out must be managed from the same position so that it is not necessary to transport the sensor from the place of exposure to a read-out station. Device read-out can be either an

electron or a laser beam. Priority should be placed on exposure of objects with 1 to 10 MeV x-ray radiation, with consideration for subsequent potential application to lower energy radiation and to neutrons.

N87-136. TITLE: Development Of High-Density Chemically Vapor Deposited Composite Materials

CATEGORY: Advanced Development

DESCRIPTION: Higher operating temperatures, and thus performance in advanced airbreathing propulsion systems are primarily limited by material capabilities. Carbon/carbon composites show good potential for propulsion system applications due to high-temperature strength, but must be protected from oxidation. Carbon/ceramic composites offer the capability of combining the structural capability of carbon fiber with the oxidation-resistance of ceramics. Carbon/carbide and carbon/diboride composites are curently being investigated for advanced propulsion systems. One approach to the development of such carbon/ceramic materials is by chemical vapor infiltration technology. A current drawback with chemical vapor infiltrated materials is the relatively low (85% theoretical) densities in thick section (over 0.25 inch) parts. The need currently exists for identification of suitable fiber architectures, innovative processing conditions, etc., which can yield high density, thick section components (over 0.25 inch) produced by CVI techniques. Fabrication advances can be via the production of plates or cylinders.

N87-137. TITLE: Fabrication Of Carbon/Ceramic Composites For High Temperature Leading Edges On Hypersonic Ramjets

CATEGORY: Exploratory Development

DESCRIPTION: The need currently exists for the materials suitable for leading edge applications in advanced hypersonic ramjet concepts. Leading edge materials require high strength, oxidation resistance, toughness, and erosion resistance up to 4000F, and the ability to be constructed with relatively sharp leading edges (i.e., 0.030 inch leading edge radius). Small diameter, high strength carbon fiber currently exists from which leading edges could be constructed utilizing appropriate fiber architectures. One approach to the protection of carbon/carbon composites is the use of alternative ceramic compounds in the matrix, yielding carbon/ceramic composites. Candidate matrix ceramics include, but are not limited to, diboride compounds and diboride composites. The material system fabrication could be demonstrated through the fabrication of 0.25 inch thick flat plates for mechanical characterization and additional plates demonstrating a 0.030 inch leading edge radius.

N87-138. TITLE: User Interactive Software For Holographic Interferometry

CATEGORY: Advanced Development

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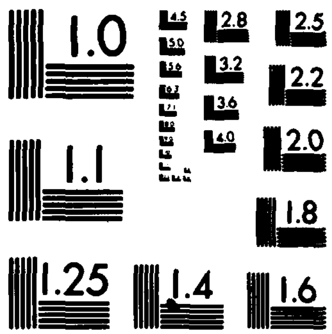

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DESCRIPTION: A need exists for automating data reduction methods used in holographic interferometry. Laser holography offers a method by which entire density flowfields can be measured experimentally about models used in windtunnel tests. Because the entire flowfield can be recorded instantly (less than one microsecond), holographic interferometry is a very promising method of investigating rapidly changing flowfields. The photographic recording of laser holograms is well understood, but the data reduction methods, although understood, have proven extremely tedious and labor intensive. The need for automated data reduction algorithms is paramount. These software routines must be carried out on a very fast computer with large amounts of memory (many mega bytes). The software must be user friendly, fast, yet sufficiently automated to analyze a wide variety of holographic interferograms. The software for the image processing should utilize both contrast and spatial techniques.

N87-139. TITLE: <u>High Optical Quality Photorefractive Single Crystals</u>

CATEGORY: Research

DESCRIPTION: A need exists to understand precisely which material parameters directly affect the production of phase conjugation and four-wave mixing in photorefractive crystals. The goal of this effort is to grow large (greater than 2 cm x 2 cm x 2 cm) high optical quality photorefractive single crystals of barium titanate, potassium tantalum niobate, barium strontium niobate, potassium niobate, and strontium titanate. Both pure (i.e., intrinsic or undoped) crystals and also crystals doped with controlled amounts of impurities such as iron and/or manganese and/or rare earth ions are required in order to compare the effects which these elements have on phase conjugation efficiency.

N87-140. TITLE: <u>Investigations Toward A Nonvolatile, Ferroelectric Random Access Memory</u>

CATEGORY: Research

DESCRIPTION: A nonvolatile random access memory (RAM) with viable performance and economic parameters could be constructed if a suitable ferroelectric material were substituted for the dielectric in the capacitors of a Dynamic RAM. The ferroelectric material should be easily deposited, sputtered, or otherwise controllably grown and have properties compatible with subsequent MOS processing. The material should switch at a volt or less and in 20 sec or less using a 2 volt drive. A defect-free thin film which retains its polarity and does not fatigue or break down with a 3.5 volt drive is required. During the research phase of this program it is sufficient to fabricate small capacitors to demonstrate the ferroelectric properties rather than construct a modified DRAM. The proposal should identify at least two materials likely to fulfill the requirements along with reasons supporting the choice of materials. The end result of this phase of the work will be a demonstration of and report on the switching speeds and hysteresis curves of the chosen materials.

N87-141. TITLE: Synthetic Techniques For Cloud/Sea Infrared Radiance Maps

CATEGORY: Exploratory Development

DESCRIPTION: Background cloud clutter represents the principal performance limitation of Infrared Search and Track (IRST) sensors operating from shipborne platforms. The goal of this work is a computer model to generate cloud and sea radiance maps to be compared with and validated by the experimental data base being acquired by the Navy's Background Measurement and Analysis Program (BMAP).

N87-142. TITLE: Reliable Real-Time System Development

CATEGORY: Advanced Development

DESCRIPTION: Reliability and time constraints are critical issues in the design of real-time tactical systems. The purpose of this effort is to develop or extend formal specification language and automated system requirements design and analysis tools to include the concept of time and reliability for such systems. Time and reliability should be treated as top level parameters throughout both design and analysis activities. The specification language and the toolset should operate at multiple levels from top level requirement specifications detailed system design. It should be able to make trade-offs analysis for scheduling processes on a given machine description under normal and highly stressed conditions at all levels.

N87-143. TITLE: Development Of A Combatant/Squadron Level Automation System for Management Of Readiness, Operations, And Maintenance

CATEGORY: Management and Support

DESCRIPTION: The Navy has on-going a great deal of effort developing and applying fleet experience data collection and information feedback systems. Software applications which make use of modern computer technology offer an opportunity to satisfy both combatant/squadron and higher fleet and support commands information needs and objectives with much greater efficiency at greatly reduced manpower and cost expenditures. There is a need to make use of such software and computer technology at the combatant/squadron level to assist in mission essential equipment configuration management, readiness determination, and logistic element forecasting, as well as concurrently satisfying basic maintenance and material management information feedback needs.

N87-144. TITLE: Optical Signal Processing

CATEGORY: Advanced Development

DESCRIPTION: High speed signal processing for intelligent weapons can be achieved through the use of optical computer systems. Optical pro-

cessor concepts that can interpret target information in real-time are solicited.

N87-145. TITLE: High Density Power Sources For Robots

CATEGORY: Advanced Development

DESCRIPTION: One of the major barriers to continuous autonomous operation of mobile robots is performance of available power sources. Lightweight, long-term stable power sources, which tolerate environmental extremes (e.g. high/low temperature, humidity, shock), are required for the operation of robot control electronics. In addition, bursts of power for mobility, heavy lifting, and other mechanical functions are often required. High density power sources that can provide these capabilities over long periods of time with minimal maintenance are of great interest. Advanced power systems, including hybrid concepts that integrate available power sources, should be investigated to meet the needs for long-term, low-level robotic operation with surge capabilitties for high-power demands.

N87-146. TITLE: Parts-On-Demand Manufacturing Work Cell

CATEGORY: Engineering Development

DESCRIPTION: A requirement exists for a highly automated, parts-on-demand manufacturing capability able to produce small number's (1 to 200) of critical military electronic and mechanical components as required, rather than relying on large inventories of spare parts to meet operational requirements. Concepts employing extensive use of highly flexible automation to reduce manpower requirements and increase quality and reliability should be explored.

N87-147. TITLE: Real Time, 3-D Computer Vision

CATEGORY: Advanced Development

DESCRIPTION: Passive machine-vision is required for use in robots, autonomous systems, manufacturing, and other military applications. Systems that can provide near real-time (video frame rates) image understanding, including ranging and classification of objects in 3-D space are of particular interest.

N87-148. TITLE: Advanced General Purpose Controller

CATEGORY: Advanced Development

DESCRIPTION: Develop an advanced, compact, microprocessor based, multipurpose controller for real time sensory understanding and adaptive control of weapons, robots, factory automation and other control applications. The concept should employ a highly distributed, hierarchical architecture to enhance performance and flexibility. Investigations should include software/hardware architecture, software design methodologies, interface designs, protocols, bus architecture,

microprocessor selection, high level languages, programming aids, packaging and other design parameters.

N87-149. TITLE: Application of Robotics Technology To Performance Of Hazardous Tasks At Maintenance Facilities

CATEGORY: Engineering Development

DESCRIPTION: Robotics technology is revolutionizing manufacturing in almost every major industry. There is a similar potential for the use of robotics technology to perform hazardous or labor intensive tasks at depot and intermediate level maintenance facilities. Applications include but are not limited to such areas as painting, plating, cleaning, corrosion treatment, tire repair, and battery servicing.

N87-150. TITLE: Development Of Inexpensive VCR Training

CATEGORY: Management and Support

DESCRIPTION: Most training and information films and video tapes used by the Navy are produced by professional film and TV production people using expensive equipment and traditional production methods. Video Cassette Recorders and Television Cameras have recently become very reliable, easy to use, and are relatively inexpensive. There is a need to use this technology to develop training, information, and instruction modules that could be very useful in enhancing a wide range of different training programs and for providing operational instructions for the performance of complex tasks.

N87-151. TITLE: Shipping Container Design And Labeling Improvement

CATEGORY: Engineering Development

DESCRIPTION: There have been many improvements in packaging, handling, and labeling methodologies which have not been utilized by the Navy. There exists a great deal of inefficiency, confusion, duplication and many errors in the present system. There is a need to develop an efficient system of labeling and to improve and standardize the packaging and handling of components, subsystems and systems.

N87-152. TITLE: New Technology Test And Measurement Systems

CATEGORY: Advanced Development

DESCRIPTION: Recent trends in automatic testing technology together with higher levels of circuit integration are leading to more compact and efficient Automatic Test Equipment (ATE) for board and assembly level test and fault isolation. ATE system architectures incorporating complex analog, digital, and RF stimulus and measurement functions in integrated bus structures offer advantages in performance, size, power consumption, and life cycle costs. There is a need for development of ATE systems incorporating integrated instrument functions, robotics and

advanced flexible automation that would perform equally well in the factory, repair depot or field environment.

N87-153. TITLE: Naval System Issues For Charge Particle Beams

CATEGORY: Exploratory Development

DESCRIPTION: The thrust of this research would be to take existing and planned CPB weapon components and address system issues such as radiation effects on ship and personnel, logistics, EMP and noise effects.

N87-154. TITLE: Real Time Dynamic Analyzer For Quality Control Of Rubber Products

CATEGORY: Advanced Development

DESCRIPTION: Development of a meaningful, fast, accurate and precise dynamic mechanical testing apparatus and procedure for characterizing rubber products to meet the Navy's acoustic requirements. The procedures and apparatus must provide for dynamic mechanical property evaluations of new, high performance rubber formulations (R&D environment) as well as for real time quality control materials evaluation in a manufacturing environment.

N87-155. TITLE: Corrosion Testing Of Metal Matrix Composites In Hostile Environments

CATEGORY: Exploratory Development

DESCRIPTION: Proposals are sought for practical methods for characterizing the corrosion behavior of metal matrix composites in marine environments. For example, the validity of advanced potential-controlled methods used in the characterization of the pitting behavior of metal matrix composites may be considered. In addition, protective coating studies should be incorporated in the study to determine their effectiveness in inhibiting corrosion.

N87-156. TITLE: Improved Methods For The Synthesis Of Difunctional Fluoroalcohols

CATEGORY: Research

DESCRIPTION: Fluorodiols are building blocks for a variety of fluorinated polymers with potential uses as coating materials and binder components for plastic-bonded explosives and propellants. To permit tailoring of polymer properties, new types of fluorodiols are needed. In addition, efficient methods for the synthesis of new as well as known fluorodiols are needed to enable their manufacture at reasonable costs. Examples of fluorodiols which are of interest for above applications have the following general structure:

$$HO(CH_2)n(CF_2)m(CH_2)_nOH \ (n = 1,2; m \leq 3)$$

Structural variation of these prototypes might include branching and the presence of hereto atoms in the backbone or side chain.

N87-157. TITLE: Synthesis Process For BIS(Dinitropropyl) Formal/Dinitrobutyl Dinitropropyl Formal Plasticizer (BDNPF/DNBPF)

CATEGORY: Exploratory Development

DESCRIPTION: The title mixed plasticizer has many properties very similar to the nitroplasticizer BDNPF/A. However, BDNPF/DNBPF is more thermally and chemically stable, which should result in improved shelf-life and compatibility with energetic ingredients. In addition, BDNPF/DNBPF is potentially less extensive than BDNPF/A. A practical synthesis method for the plasticizer mixture must be demonstrated based on existing chemical reactions: A 3:1 mixture of 2,2-dinitropropanol and 2,2- dinitrobutanol is prepared from a mixture of the mononitroalkanes via an oxidative nitration or chlorination/ter Meer process. The mixture of nitro-alcohols is then reacted with formaldehyde/sulfuric acid to produce the desired formal mixture in one step.

N87-158. TITLE: Software Engineering Environment For Parallel And Distributed Systems

CATEGORY: Advanced Development

DESCRIPTION: The future generations of Navy Combat Systems will be based on parallel and distributed processing architectures. System design and in particular, software design and programming for these environments will be orders of magnitude more difficult than anything we face now. The purpose of this effort is to assess current capabilities and to design a software engineering environment for the development of parallel and distributed real-time software. The environment should cover functions from requirements, functional decomposition to program design and automatic code generation. Language study should include Ada, and the software environment should be as automated as possible.

N87-159. TITLE: Integrated System For Numeric And Symbolic Computations

CATEGORY: Advanced Development

DESCRIPTION: It is clear that the next generation of tactical systems will include heavy requirements for both numerical and symbolic computing. However, these computing functions must reside in a single system. The purpose of this effort is to study the integration of numeric and symbolic functions into a single system, and the requirements of such a system. Included in the study should be the requirements of a development system and the language issue, such as whether Ada can be used as a single language and how well it will satisfy all the computing functions.

N87-160. TITLE: High Performance Optical Image Processor

CATEGORY: Exploratory Development

DESCRIPTION: Currently available image processors are limited by the size, complexity, speed and power requirements of conventional digital computers. Image understanding systems are required to perform target detection, location, and classification in real time through the use of optical elements that manipulate signals, images and other target information. Concepts employing optical sensing, holographic correlation, image enhancement, feature extraction, multisensor fusion and similar optical techniques will be considered.

N87-161. TITLE: Conductivity Meter For Graphite Epoxy

CATEGORY: Advanced Development

DESCRIPTION: Fiber reinforced polymer matrix composits such as graphite epoxy are being used to an increasing extent in structures ranging from aircraft to computer housing. The electrical conductivity of these materials determines both the electrical shielding they provide and applicability of electromagnetic nondestructive inspection techniques. The materials are usually in the form of flat plates in which the conductivity is aniostropic. A device is needed which will measure the conductivity of the plates as a function of orientation relative to the fiber direction. Special problems are presented by the difficulty in achieving good electrical contact and by the low conductivity of the materials (less than 0.1% of the International Annealed Copper Standard). The device should measure the conductivity over a large cross-section relative to the cross-section of the fiber toes. It must measure the conductivity from DC to 6MHz and the accuracy of the device must be demonstrated.

N87-162. TITLE: Automatic Engagement Planning

CATEGORY: Exploratory Development

DESCRIPTION: A major opportunity for technology insertion exists in the area of multi-ship, multi-target cruise missile engagement planning. Current Anti-Surface Warfare (ASUW) systems support engagement planning generally at the single salvo level. Yet ASUW depends for its effectiveness on the ability of the striking force to produce a coordinated attack. This a productive area for advanced mathematic studies.

N87-163. TITLE: Unwanted Radar Waveform Modulation

CATEGORY: Advanced Development

DESCRIPTION: Radar systems are characterized by waveform characteristics. Generally, the waveform characteristics of a specific radar are the same from radar set to radar set. However, it is known that unwanted modulation on pulse due to differences in operating environ-

ments, component aging, and other reasons, results in unique waveform characteristics within the same type of equipment. Methods are sought that eliminate unwanted modulation or permit it to be changed in a controlled way. All types of radars should be considered.

N87-164. TITLE: Multipath Modeling

CATEGORY: Exploratory Development

DESCRIPTION: Shipboard radars are subject to tracking errors resulting from multipath effects off the water. Simulations of radar tracking low flying missiles require models of these effects in all sea states. Innovative approaches to modeling radar multipath tracking errors are sought. Of particular interest is X-band and Ka-band radars.

N87-165. TITLE: Software Development Productivity

CATEGORY: Exploratory Development

DESCRIPTION: Software development productivity can be affected by the mean by which the developer interacts with the computer, e.g., typing in text. Methods are sought for alleviating this man/machine bottleneck by means of voice input. An example might be voice recognition to provide the textual input for a diagrammatic language.

N87-166. TITLE: Generalized Fire ControL System Design

CATEGORY: Advanced Development

DESCRIPTION: Fire control systems for gun and missile weapon systems in general perform similar types of functions. Most existing fire control systems (or weapon control systems) have been developed as a unique set of equipment and software to solve very specific problems. It is felt that a generalized approach to fire control system design should be possible that would result in a uniform design applicable to any new start.

N87-167. TITLE: Attribute Based Track Correlation/Classification

CATEGORY: Exploratory Development

DESCRIPTION: The problem of surface contact correlation consists of two major steps: deciding which contacts should be grouped together as a single real vehicle and producing smoothed state estimates for the resultan track. While the latter problem has been worked extensively, the former problem of correlation, particularly based on full use of attribute information, has not been fully developed. The area of attribute-based correlation/classification may be a good expert system application.

N87-168. TITLE: Coding Of Color TV Signals For Encryption

CATEGORY: Advanced Development

DESCRIPTION: Color TV signals conforming to the NTSC standard are transmitted for telemetry purposes throughout test ranges in two major application areas; air-to-ground and ground-to-ground. It is required for national security reasons that these signals be encoded to permit transmission by digital means rather than by conventional analog techniques. Compression of an imaging video system with full motion, high resolution, NTSC standard analog video into possibly as high as a 50 Mb/S binary digit stream; also, of limited motion and/or reduced resolution imaging video into a 10 Mb/s binary digit stream to be compatible with data processing and security equipment is of interest. The purpose of this task is to investigate alternative techniques to perform this coding process. The key technical objective is the maintenance of the maximum possible, subjective image quality over the range of transmitted bit rates.

N87-169. TITLE: Low Cost Accelerometers

CATEGORY: Advanced Development

DESCRIPTION: With few exceptions, inertial sensor manufacturers are striving toward lower and lower cost gyros and succeeding. Very shortly, the gyro will be cheaper than the accelerometer. This is not acceptable since accelerometers are relatively simpler devices. Because the accelerometer is a technically less demanding device, it really does not take the resources of a large aerospace company to develop a low cost accelerometer. The performance of the accelerometer should be consistant with missile midcourse guidance requirements. Accelerometer bias should be between 200 and 800 micro-g's, scale factor error should be between 200 and 500 PPM, and the dynamic range should be ±25 g's to ± 50 g's. One acccelerometer is not expected to cover this entire performance regime. Power consumption and size should be consistant with solid state technical approaches. The projected cost of the device should be less than $500 including electronics.

N87-170. TITLE: Acceleration Driven Energy Interruptor

CATEGORY: Advanced Development

DESCRIPTION: The purpose of this effort is to develop an acceleration driven electrical energy interruptor such as a normally open switch or transformer to be used on a safety-arming (S-A) device in a guided missile. The purpose of the energy interruptor is to insure that the guided missile has travelled a safe distance from the launch platform, i.e. a ship or an aircraft, prior to allowing the transfer of energy from the guided missile battery to the firing circuits in the S-A device. Specifically, two energy interruptors will prevent the flow of electrical energy to the explosive initiator firing circuits until the missile has reached a safe distance from the launcher in accordance with paragraph 4.3.3 b. of MIL-STD-1316C. The interruptors will be capable of passing a direct current of from 100 to 300 milliamperes for two seconds. The system will function after being subjected to the standard military environment such as five foot drop, temperature, and humidity cycling, shipboard and transportation vibration and extreme

temperature storage. The interruptor shall not exceed 1.5 inches diameter or 3 inches length.

N87-171. TITLE: Near Net Shape Sapphire Domes

CATEGORY: Advanced Development

DESCRIPTION: Sapphire is ideally suited for missile domes due to its high optical quality, high transmission, and low residual stress. However, manufacturing costs are very high, prohibiting utilization of sapphire on missile systems. The objective of this work task is to develop techniques to manufacture full-scale, near net shape, single-crystal sapphire domes. Limited, small scale sapphire crystals have been produced by the industry. There is now a requirement to develop the techniques necessary to grow low cost sapphire crystals to a scale usable on missile systems and at rates compatible with production requirements. Present processes for providing full-scale sapphire domes include growing a solid boule then scooping, grinding, and polishing the sapphire to the final shape. This is a very expensive process. In fact, the costs are high enough that no U.S. missile programs are using sapphire domes, which limits the capabilities of the missile. Industry has been investigating methods of growing near net shape sapphire crystals. Their limited efforts give strong indications that these processes could be scaled up to provide low cost sapphire domes at high production rates. These methods need to be defined in detail, and the feasibility of the full-scale processes needs to be demonstrated.

N87-172. TITLE: Processing Improvements In Chemical Vapor Deposited Zinc Sulfide And Zinc Selenide IR Window And Dome Materials

CATEGORY: Exploratory Development

DESCRIPTION: The development of missile domes and imaging devices for the 10-14 μ region is complicated by a lack of availability of suitable window materials. The most commonly used long wavelength material is germanium, however, aerodynamic heating in high speed missile applications cause serious degradation of its infrared transparency. Materials with larger electronic band-gaps than germanium, such as zinc sulfide and selenide are optically stable at higher temperatures, but are generally soft and subject to erosion damage by impacting high velocity particles such as rain drops or sand. Efforts to improve the resistance of these materials to the erosion effects of impacting particles by the control grain size, ion implantation, or the application of hard coatings has not been successful because of the persistence of particle induced surface crack initiation and the propagation of fractures into the material. The fractures, in turn, reduce the transparency as well as the fracture strength of the material. The objective of this work is to improve the mechanical and optical stability in CVD zinc sulfide and zinc selenide in a rain erosion environment through improvements in material processing parameters. Surface flaws and microstructure of CVD ZnS and ZnSe material that are critical to crack initiation and propaga-

tion in a rain erosion environment will be identified. Then, process modifications to improve the microstructure and surface finishing techniques to reduce the surface flaws will be investigated. Improvements in material quality and surface finishing will be validated by rain erosion tests and appropriate optical and mechanical property measurements.

N87-173. TITLE: High Temperature Turbine For Missile Power Generation Applications

CATEGORY: Advanced Development

DESCRIPTION: Design and fabricate a turbine wheel for missile power generation applications. The operating gas temperature range of interest is 2500°F-3500°F The turbine should be capable of operating with air as the operating gas. The construction should be of a ceramic or composite material. The operating life is 100 hrs at a design speed of 100,000 rpm. The turbine efficiency should be 50% or higher to minimize the mass flow rate requirements. The shaft power output of interest is 12 KW nominal. The turbine size should be 8 inches in diameter or less. Testing could be done by the monitoring activity

N87-174. TITLE: Tuned Tactical Rocket Motor Cases For Insensitive Munitions

CATEGORY: Advanced Development

DESCRIPTION: Develop rocket motor cases that resist hazardous reactions (any response greater than burning) more effectively than current designs when subjected to the stimuli specified for the Navy's insensitive munitions (fast (fire) cookoff, slow cookoff, bullet and fragment impact, and sympathetic reaction). Reaction severity may be reduced to burning by relieving confinement prior to violent explosion or pressure rupture of the case. Strip laminate cases and composite case nave demonstrated good pressure relief in both bullet impact and fast cookoff tests. For the class 1.1 propellants that resist all but prompt detonations, it may be possible to design a motor case that can reduce the shock level transmitted to the contained propellant in a fragment impact or sympathetic detonation scenario. The case would be "tuned" by design to have at least the fast cookoff and bullet impact mitigation behavior of strip laminate and composite cases, but in addition it would be designed to attenuate the input shock levels from high velocity fragments. The physical, and perhaps chemical, behavior of the case materials may have to be carefully adjusted to fairly specific fragment velocities and sizes depending on the threat scenario and the specific propellant involved. The "tuning" may involve sandwiching layers of different materials. It may involve using metal layers and composite/fiber layers that are fabricated with specific build-in compression or tension. It may involve the use of materials that absorb energy (endothermic). Material acoustic properties would be important, as would interactions with liners, internal insulation, and with the propellant. Case design may involve combinations of these and other concepts. The work should involve development of a design methodology

for "tuned" rocket cases that uses applicable dynamic finite element design tools. Also important will be high rate mechanical property measurements to determine design variables and subscale test methods for assessing different design approaches.

N87-175. TITLE: Variable Flow Gas Generator

CATEGORY: Advanced Development

DESCRIPTION: Design and fabricate a variable flow solid propellant gas generator. The flow should be variable over a range of 0.01 lbm/s to 0.1 lbm/s. The output gas temperature will be 2500°F at a pressure between 1000-1200 psia. The output gases will be used to power turbo-machinery and is required to be clean burning and non-erosive. The burn time will be 1-2 minutes. Testing could be done by the monitoring activity.

N87-176. TITLE: Rapid Prototyping For Real-Time Embedded Computers

CATEGORY: Advanced Development

DESCRIPTION: Detailed requirements for the development of real time embedded computer systems found in avionics, missiles, and fuzes are generally not available for much of the system when the design process must be initiated. There is a need for a mechanism to develop parts of the system that are high risk and least understood early in the design phase so that both users and developers can learn and refine the requirements. The objective of this work is to develop methods for prototyping real time embedded computer systems with only high-level requirements as inputs. The methods must assist both users and developers in characterizing their systems and interactively changing the system to determine impacts to operational use. Automation of these methods should be considered, and could be hosted on either supermicro- or minicomputers.

N87-177. TITLE: Linear Measure Sensor In Dynamic/Hostile Environments

CATEGORY: Exploratory Development

DESCRIPTION: In the dynamic environment of SLBM traveling out of a launch tube accurate, reliable sensors to measure the relative small clearance between a point on the missile and a point on the launch tube is needed. Sensors can be mounted on the moving missile (e.g. missile skirt area) and/or on the stationary launch tube (e.g. tube missile area). Sensors must not physically alter launch environment and affect measurements. Sensors are to measure in real time the changing clearance (linear distance) between the tube wall and the traveling missile reference surface. Desired range of linear measurement is 1.625 + 1.00 inches with a ≈ 2% accuracy requirement. Time coded continuous reading sensor data is desired for "in-tube" launch trajectory studies. Large temperature gradient and pressure fluctuations as well as gases

must be considered in launch event/environment.

N87-178. TITLE: Metallic Material Testing Technique Correlation Or Charpy To Izod Impact Energy Correlation

CATEGORY: Advanced Development

DESCRIPTION: In metallic material development, a number of testing techniques are available. A correlation between two particular methods' - charpy impact and Izod impact energy - results (particular, stainless steels) would be useful. Present correlations between charpy and Izod results contradict each other and do not take material chemistry/microstructure/properties into account. Considering the difference in loading (cantilever vs. bending) and possible correlation differences as a function of materials and/or different strength levels of a given material, an empirical method to obtain correlation may prove more rewarding than a theoretical one.

N87-179. TITLE: Software Model Development For Matrix Composite Material Evaluation

CATEGORY: Advanced Development

DESCRIPTION: Understanding the physics of metal matrix and organic matrix composites has increased rapidly in recent years, as the application of such new materials has increased. To improve further the development or application of such matrix composites, software development based on knowledge obtained to date would be useful; in particular a fracture criteria analytical model for both organic matrix and metal matrix composites.

N87-180. TITLE: The Physics Of Metal Matrix Composites

CATEGORY: Exploratory Development

DESCRIPTION: The use of metal matrix composites in advanced missiles and guidance systems in particular is at the the introductory level at this point in time. If a concentrated development program were undertaken to improve our understanding of the physical properties of these materials, its application in areas where stability, strength, and low weight are of critical importance could be made more quickly and without unexpected risk.

N87-181. TITLE: Passive Variable Resistance Techniques

CATEGORY: Advanced Development

DESCRIPTION: Thermal stability and the absence of large thermal gradients are key design elements in maintaining accuracy through improved stability of critical alignments and also aid improved performance of the inertial components. A technique whereby the thermal resistance across a heat flow path can vary as a function of the heat flux present

would result in improved thermal stability in critical areas. In particular, the development of a compact passive variable thermal resistance device would represent a unique advance in thermal design.

N87-182. TITLE: Polyimide Quartz Multilayer Board

CATEGORY: Advanced Development

DESCRIPTION: Ceramic integrated circuit packages have a thermal mismatch when mounted on the standard epoxy fiberglass multilayer board. If a polyimide quartz multilayer board could be developed, it would provide a much closer thermal expansion match with the ceramic package. This would result in improved reliability and longer life for the electronic package.

N87-183. TITLE: Hermetic Packaging Equivalent

CATEGORY: Engineering Development

DESCRIPTION: Develop methods and standards to provide protection to Integrated Circuits (IC) equivalent to those provided by hermetic cavity enclosures (i.e. 38510 hermetic parts) without enclosing the IC in a cavity. Traditional packages are creating many problems as electronic systems shrink using new technology. Many alternatives known collectively as "Chip-On-Board" technologies have been suggested, but none have demonstrated the ability to withstand the combinations of hostile environments found by military systems. The work should start by addressing the question of relevance of current 38570 hermaticity tests to a part not in a sealed cavity. Beyond the environmental protection of the IC, mechanical protection of the IC (handling problems), manufacturability, and repairability should be addressed. New standards and test methods for non-cavity "packages" should be proposed.

N87-184. TITLE: Large Scale Integrated (LSI) Circuit Evaluation With Election Beams

CATEGORY: Exploratory Development

DESCRIPTION: Conduct an assessment of the differences and the significance of the differences between photon and electron beam excitation of LSI circuits. The following electrical parameters (magnitude and time varying response) must be considered in the study: V_{OH} V_{OL} I_{CC}. In addition the thermomechanical response shall also be considered.

N87-185. TITLE: 54 Series Advanced CMOS Replacement Of 54 Series Bipolar Devices

CATEGORY: Engineering Development

DESCRIPTION: Integrated Circuits of the 54 L and H Series are now obsolete and the 54 and 54,S types will soon follow. Military experience with the newer HC, HCT, and ACT types is minimal with respect

to their reliability and quality in high speed applications. How will these devices perform as replacements for the slower speed bipolar devices? Assessment will require test and evaluation of the new part types under Mil-Spec test conditions, an their performance in modules as substitutes for the obsolete parts.

N87-186. TITLE: Radiation Hardening

CATEGORY: Engineering Development

DESCRIPTION: Approaches are required for fabrication of power transistors which are hardened to neutron radiation. Novel ideas are needed for neutron radiation hardening of bipolar, DMOS or gallium arsenide power transistors for operation after exposure to neutron fluences of 3E14 N/CM^2. This development program will define hardening approaches, develop manufacturing techniques, produce sample transistors, and perform radiation testing as proof of concept.

N87-187. TITLE: Development Of Ferroelectric Memory

CATEGORY: Engineering Development

DESCRIPTION: It has been reported (Computer Design, March 1983) that the ferroelectric thin film such as KNO_3 may be used for non-volatile, and inherently radiation hardened memory fabrication. The Projection is 160 MB/in^2, @.001¢/BIT. Furthermore, neutron hardness well over 10^{14}, and no SEU (Single Event Upset) problem is predicted. A significant advantage over current non-volatile MNOS technology is that ferroelectric memory is known to have an endurance cycle of better than 10^{10} read/write cycles compared to 10^6 10^7 cycles of current MNOS technology: potential offerer will construct 1KB memory and study trade-off in endurance and radiation hardness problem.

N87-188. TITLE: Internally Focused Random Arrays

CATEGORY: Exploratory Development

DESCRIPTION: Develop innovative acoustic techniques such as two-dimensional adaptive beamforming or coherent frequency diversity which will allow focusing and scanning within and outside an array, thereby rejecting interfering noise sources (a major detriment to acoustic sensors today). The objectives are to: (a) provide future array systems with the unique capability of reducing their side lobes well beyond existing levels (on the order of 30 dB) and greatly enhancing the acoustic sensor's capability to discriminate against noisy targets on or off the main beam axis; (b) define the processing load and update time required to achieve this amount of suppression; and (c) establish the number of sensors and array gain achievable commensurate with the derived approaches. Since the technique does not require a specific frequency bandwidth combination, it has extraordinarily great potential for implementation into all methods of signal processing.

N87-189. TITLE: Emergency Rotor Blade Removal From A Helicopter

CATEGORY: Engineering Development

DESCRIPTION: Develop a methodology and prepare a generic design to remove the helicopter rotor blades from an aircraft in a flight emergency so that a parachute system may then be used to recover the inhabited fuselage. A significant problem associated with severance or removal of the blades is that they may become a free flying hazard to other aircraft flying in formation or in its vicinity. Analyze the system safety of the design against inadvertent actuation because of component failure, sneak circuits, EMI, etc.

N87-190. TITLE: Expendable Glider

CATEGORY: Advanced Development

DESCRIPTION: Design a device which can be attached to a small free-fall cylinder to cause it to glide. The device should be contained in a package 4.5 inches in diameter by 1 inch high. It must deploy after ejection from an aircraft flying at 200 knots. It must be capable of carrying a payload which is 4.5 inches in diameter by 6 inches high weighing up to 3 pounds. The device should orient its glide direction transverse to the direction of the aircraft. A glide angle in excess of 45^{o} from verticle is desired. The device must be expendable and inexpensive ($1-2 in 500,000 quantities).

N87-191. TITLE: Flight Control Actuator Electronics Cooling

CATEGORY: Exploratory Development

DESCRIPTION: Develop innovative approaches and new techniques to provide cooling for electronic assemblies mounted on the bodies of flight control hydraulic actuators. The objective is to make it feasible to incorporate loop closure and redundancy management electronics on or within the flight control actuator, thereby reducing wire count between the actuators and flight control computers. Anticipated actuator case ambient temperatures may be as high as 300^{o}F. A highly reliable cooling method will be needed to operate flight critical electronics in this environment.

N87-192. TITLE: Sonobuoy Cables Of High Strength Spectra Materials

CATEGORY: Advanced Development

DESCRIPTION: Since sonobuoy cables must have high strength and small diameter, many are presently constructed with a high strength member of Kevlar. The high strength polyethylene materials Spectra 900 and Spectra 1000 have reported higher strength and lower weight than Kevlar. Evaluation of Spectra materials for sonobuoy cables requires the design, fabrication, and testing of cable samples in comparison to comparable

Kevlar designs. A commonly used sonobuoy cable consists of a copper core (7 strands of AWG36) insulated with 10-mil thick Surlyn for water integrity; around this is the strength member, an 8-end braid of 1000 denier Kevlar 29 with cordage finish. The diameter of this cable is 0.058-inch maximum, and its breakstrength is 325 lb minimum in lengths of 17,000 ft. It is desirable to investigate a smaller diameter cable with equivalent breakstrength and a stronger cable with the same diameter. Both braided and served constructions should be considered. Minimum lengths of 10,000 feet should be fabricated and tested at various sections along the cable length. Testing should include stress-strain, breakstrength (straight tension and over pins of 1-inch and 2-inch diameter), cyclic tension to break at 100 lb ±50 lb (straight and over 1-inch and 2-inch diameter pins), and cycles over a sheave of 1-inch and 2-inch diameter at 100 lb tension. Data should be in a form useful for the design of an improved sonobuoy cable using Spectra material.

N87-193. TITLE: Methodology For Predicting Canopy Fracturing Patterns During Ejection

CATEGORY: Advanced Development

DESCRIPTION: The objective is to develop an inexpensive and effective methodology for determining the optimized placement of detonating cord to predictably weaken and fracture an aircraft canopy for penetration by an ejection seat during crewmember emergency escape. Develop a finite element model to represent an aircraft canopy. Exercise the model by applying theoretical point loads to the canopy at the location where the ejection seat canopy breakers normally contact the structure during an ejection. The resulting stress pattern will identify the canopy areas that are potentially suitable for canopy fracturing using mild detonating cord. Exercise the model with mild detonating cord located at the weakened areas identified initially. Determine breakout pattern.

N87-194. TITLE: Low Frequency Underwater Sound Calibration Source

CATEGORY: Advanced Development

DESCRIPTION: A low frequency, non-explosive, sonar projector is required to perform acoustic calibrations at sea. Specifically a highly efficient projector capable of one watt acoustic output at a mechanical resonance below 500 Hz is needed with physical dimensions such that it may be installed in a cylindrical shell with a diameter not exceeding three and one half inches and a length not to exceed 18 inches.

N87-195. TITLE: Split Transformer Performance Modeling

CATEGORY: Exploratory Development

DESCRIPTION: Develop a model to predict the performance of a split transformer in a conducting seawater environment. Parameters that need be modeled include: size, materials, separation distance and amount of "disorientation", seawater conductivity, power transmitted, operating

frequency, etc. The effects of the conducting seawater need to be quantified, e.g., electromagnetic field shape and eddy or other current within the seawater that dissipate the energy being transmitted.

N87-196. TITLE: Short Range Communication

CATEGORY: Advanced Development

DESCRIPTION: There is a need to develop a short range (<1000 yards), bi-directional communication system for undersea applications. The "transmitter/receivers" must be able to operate with various sound velocity profiles, water conditions and depths, surface and bottom conditions, etc. The method, approximate size, and energy level requirements need to be quantified.

N87-197. TITLE: Electromagnetic Launcher Brush Rail Interface

CATEGORY: Engineering Development

DESCRIPTION: This task is the investigation of the problems associated with the electro-magnetic launcher brush-rail interface in a conducting medium. Problems to be investigated include corrosion, wear, and electrochemical reactions due to the high current densities achieved at launch . End products include material selection and brush design to minimize or eliminate specified problems.

N87-198. TITLE: Transient Electromagnetic Field Prediction Of An Electromagnetic Launcher

CATEGORY: Exploratory Development

DESCRIPTION: Develop an analytical prediction scheme which will predict the distribution and strength of the electromagnetic field produced by a submarine electromagnetic launcher system in a conductive fluid, such as seawater. This numerical analysis will also have the ability to predict the shielding capacity of the material and geometries used in an electromagnetic launcher. All computer programming prepared must be compatible with a VAX 11/780 computer and the source code must be a deliverable on the contract.

N87-199. TITLE: Three-Dimensional Transient Flow Prediction

CATEGORY: Exploratory Development

DESCRIPTION: Develop a computer code capable of accurately predicting incompressible transient turbulent flow fields using the finite volume technique. The code should be applicable to three dimensional internal and external flow problems and be in the form of generalized curvilinear coordinates to include cartesian, cylindrical, and spherical space. The algorithm should be capable of performing both fully elliptic and elliptic-parabolic analyses. As a minimum, the turbulence model should

be the two-equation K-E development. Detailed documentation of the complete code development should be provided including comparisons to available (in the literature) experimentation. The code is to be compatible with a VAX 11/780 Computer and the source code must be provided.

N87-200. TITLE: High Speed Particle Trajectory Measurement

CATEGORY: Advanced Development

DESCRIPTION: Laminar flow offers significant payoff to undersea vehicle by providing drag reduction and reduced radiated noise. It has been shown that small particles can cause laminar flow to become turbulent. A technique is needed to measure the trajectory a particle takes as it moves past an underwater vehicle. Specifically it is necessary to determine a high-speed, small particulate's position very accurately (within one particle diameter) as it moves past underwater vehicle in a water tunnel frame of reference. It is necessary to track these particles over a length of several feet as they pass around the nose of the vehicle. Particle size ranges from 50 to 200 microns and the particle speed up to 50 ft/sec. The particle may pass very close to the vehicle (within the boundary layer). The vehicle may have a diameter up to 12 inches. Technologies that have been considered include tracking fluorescent particles passing through a sheet of ultraviolet light, and tracking particles as they pass through a light sheet created using an oscillating laser beam. These techniques may be improved or new technologies developed to achieve the desired result.

N87-201. TITLE: Robust Surface Heaters

CATEGORY: Engineering Development

DESCRIPTION: These heaters or heating techniques should be controllable and applicable to a complex curvature surface. The heat flux required is in the range of 10 to 30 KW/ft. These heaters are used in seawater to heat a submerged axisymmetric shell section ranging from 6 inches in diameter to over 21 inches in diameter. It is desirable to have the heaters resistant to moisture and high temperatures. Technologies that have been considered in the past utilize tubular nichrome wire heaters, which proved to be susceptible to high moisture levels.

N87-202. TITLE: Fabrication Of Non-Spherical Particulates

CATEGORY: Engineering Development

DESCRIPTION: The ocean contains a variety of small scale particles known as plankton. In order to simulate the ocean in tow tank and water tunnel testing, it is desirable to seed the water with artificial particles. Particles in the size range from 30-1000 microns and with a specific gravity in the range of 1.01-1 30 are required. The desired shapes include rods, disks, "bristle brush", octopus shaped" or any other geometric shape. These particles must be capable of keeping

dispersed in freshwater and saltwater and should be sufficiently robust to last at least one week submerged.

N87-203. TITLE: Thermal Conducting Plastics

CATEGORY: Advanced Development

DESCRIPTION: A nonmetallic material is being sought that can be used to manufacture coatings or complete sections of prototype coverings for heat exchangers which are submerged in saltwater for long periods of time. These coatings should be resistant to the seawater exposure and at the same time provide excellent thermal conductivity. An added bonus would include structural integrity to allow fabrication of heat exchanger subsections entirely out of the nonmetallic material. The axisymmetric models are 6-21 inches in diameter and 3-15 feet long.

N87-204. TITLE: Laminar/Turbulent Flow Detector

CATEGORY: Advanced Development

DESCRIPTION: Laminar flow experiments are frequently conducted in tow tanks and water tunnels using axisymmetric models that are 6-21 inches in diameter. A significant problem in these tests is to determine whether flow is laminar or turbulent at a given point on the model surface. An instrument/sensor package is required which can make nearly simultaneous multipoint evaluations of laminar/turbulent flow condition. These measurements should be real time at a rate of one Hz or better. The instrument would operate preferably, but not necessarily, from within the model. The sensors must not protrude beyond (or ideally not even penetrate) the model surface. The package must be capable of operating in freshwater or seawater. Heat flux, active or passive acoustics, electromagnetics, or any other methods may be employed.

N87-205. TITLE: Architecture Modeling

CATEGORY: Advanced Development

DESCRIPTION: A need exists for the development of architecture modeling methodologies for evaluation of complex information management and command and control system architectures for both manned and autonomous system applications. These systems require sophisticated processing necessary to convert low level data from multiple sources into high level information needed for intelligent decision making and appropriate response. The architecture must provide the signal processing, data sorting, data fusion, information extraction, pattern recognition, hypothesis testing, decision making, control laws, etc. within the appropriate time intervals, and with the appropriate disciplinary mix (e.g. interfacing symbolic processing with numerical techniques), while maintaining the required reliability, flexibility, adaptablity and overall performance. Simulation models utilizing realistic test beds are needed for parametric evaluation of critical system performance parameters in order to establish architectural requirements and/or eva-

luate candidate architectures.

N87-206. TITLE: Transient Electromagnetic Flowmeter

CATEGORY: Engineering Development

DESCRIPTION: Develop a 21 inch inside diameter electromagnetic flowmeter capable of measuring transient volumetric flowrates with a data rate of at least 250 Hz. The measuring fluid is water between 40 degrees F to 120 degrees F. Flow accelerations and decelerations up to 4 g's and velocities from 0.5 to 50 fps must be measured with a total accuracy of ±2% of reading or better at each meter output update. Meter is to have both analog (0 - 10V) and digital output and an upper range span setting adjustment between 25 and 50 fps. Meter is also to be capable of operating at steady state conditions for an indefinite period of time.

N87-207. TITLE: Real-Time Forecasting Of Future Ship Motion

CATEGORY: Advanced Development

DESCRIPTION: Investigate concepts for development of real-time methods to forecast future ship motion. Proposals which address the development, design and implementation of a device/system to forecast future quiescent periods in ship motion are solicited. The device is to be utilized during V/STOL aircraft recovery operations aboard air capable ships. Efforts are to be identified from the following areas: (a) Specification of additional naval applications of such a methodology and the requisite forecast periods; (b) Investigation of the relevant capabilities of existing and proposed forecast techniques (both operational and theoretical); ocean wave measuring techniques and devices; ship motion measuring devices; and, ship motion models which predict the responses of a ship to known forcing functions; and (c) Development/identification of computer programs, methods, and devices for operational real-time ship motion forecasting; and, the necessary ocean wave and ship motion measuring techniques and devices.

N87-208. TITLE: CV Fixed Wing Aircraft Tracking & Surveillance System

CATEGORY: Exploratory Development

DESCRIPTION: US Navy Carrier (CV) fixed wing aircraft use a "long approach" during night time operations or during periods of limited visibility such as dawn, dusk, or adverse weather (rain, fog, snow, sleet, etc.). Aircraft typically form up for a straight line approach to the carrier at eight to ten nautical miles, with aircraft spaced 1.5 to 2.0 nautical miles apart. To effect a reduction in CV approach and landing mishaps, it is desired to develop an all weather, all operating environment and all climate system for aircraft surveillance, automatic (computer graphics) aircraft type identification, and 6 d.o.f. tracking. Surveillance and tracking information shall be passed to Primary Flight Control and to the Landing Signal Officer Station. The system shall

also be capable of operating in an Emission Control (EMCON) environment with a low Probability of Intercept (LPI) for electrical, magnetic and thermal signatures. Specific requirements are:

Aircraft Surveillance	4 nm or greater
Aircraft Tracking	2 nm or greater
Aircraft Configuration (Hook down, Landing gear down, etc.)	1 nm or greater
Automatic Aircraft Type Identification	2 nm or greater

Using a system approach, the contractor shall investigate the utilization of a sensor or a combination of sensors such as FLIR, Laser, Millimeter Wave, Solar Blind Ultra Violet, etc. for attainment of the above objectives. The contractor shall conduct trade-off studies to devise an optimal system architecture. The evaluation criteria shall include, but not be limited to, performance, development risk, predicted reliability, expected maintainability and logistics support requirements, development schedule and costs as well as estimated life cycle costs.

N87-209. TITLE: Approaching Carrier Aircraft Extended Range Glideslope System

CATEGORY: Advanced Development

DESCRIPTION: Presently the useful range of the Fresnel Lens Optical Landing System (FLOLS) is one nautical mile (nm). This is the only glide slope information presented to approaching carrier aircraft. It is desired to extend glide slope information to two nm. Vendors shall submit proposals outlining conceptual systems for satisfying Navy needs. The system shall satisfy all Navy requirements for all aircraft approach and landing operations in all weather, all environment, day/night/dawn/dusk and during Emission Control (EMCON) conditions. Phase I efforts shall include, but not be limited to, trade-off studies relative to the feasibility of the concept, definition of system performance and development risk as well as presentation of a development plan with major milestones and costs.

N87-210. TITLE: Aircraft Support Equipment Shock Response

CATEGORY: Advanced Development

DESCRIPTION: Current shipboard support equipments have inadequate design capability to resist expected shock levels. It is therefore required to develop concept algorithm and associated software for parametric analysis of shipboard-installed aircraft support equipment with respect to response to underway shock levels induced by (a) heavy weather operations and (b) severe combat operations. Analytic procedure shall have flexibility to consider overall equipment shock response based upon summation effects of individual internal components (crt's, tape drives, pc boards). Format shall be compatible for use in engineering analyses to determine shock requirements for specific vessel

types and mounting locations for proposed new systems or for retrofit mounts of existing systems.

N87-211. TITLE: Automation Of Shipboard Bomb Assembly Operations

CATEGORY: Engineering Development

DESCRIPTION: Design, fabrication, and demonstration of an automated bomb assembly system for a carrier based environment. The system must be flexible, capable of handling four bomb types. The functions should include loading onto conveyor, removal of shipping screws, fuze caps/nose plugs, and installation of fuzes and fins. Installation of fin release wires and fuze arming wires will remain manual operation. Then off loading onto transporting vehicle. Current operation utilizes 4 two man teams, bomb types handled include MK81, MK82, MK83 and M117A1. Other constraints include, the system should not occupy much more space than approximate 18 ft. x 9 ft. x 8 ft. and the operation must be capable of being done manually should failure occur, and must achieve better than 9 minute cycle time.

N87-212. TITLE. Non-Destructive Evaluation Of Composites

CATEGORY: Advanced Development

DESCRIPTION: Atmospheric condensation, rain and icing conditions cause water ingress in composite materials, and water being entrapped in aircraft honeycomb structures due to cracks and defective adhesive bonding. A non-destructive evaluation method is required to detect the presence of water entrapped in aluminum and nomex honeycomb structures bonded to aluminum and composite materials, and to assess water ingress in composite materials such as graphite/epoxy and glass/epoxy. The method must be operable by field personnel at the operational or depot level with a minimum amount of training.

N87-213. TITLE: Fins And Wings Made Of Molded Matrix Material

CATEGORY: Advanced Development

DESCRIPTION: The SPARROW would benefit from a low-cost alternate source for wings and fins. The wings and fins should be constructed of high-strength matrix metals or materials, and be molded with minimum machining. The resulting wings and fins must have rigidity, aeroelasticity, and bending mode characteristics that will avoid wing buzz and wing flutter frequencies and modes. The weights should be uniform to within 0.25 lbs, and leading edge should be 0.003 inches thick. See SPARROW wing and fin specifications.

N87-214. TITLE: Infrared Target Source For Missile Test And Evaluation

CATEGORY: Engineering Development

DESCRIPTION: At present, R.F. guided missiles are tested in the laboratory using hardware-in-the-loop (HIL) simulations that require a moving R.F. target source. This R.F. source is usually moved by some mechanical means. Future missile designs are planned which will incorporate infrared seekers and R.F. seekers on the safe missile for multimode guidance. In order to test these new designs in the laboratory, an infrared (IR) target source will have to be incorporated into the R.F. target source. Various parameters of the IR source need to be controlled so that the missile IR seeker will be stimulated as it would be during an actual target engagement. Some of the parameters to be controlled are: (a) intensity - a function of range, target type and target aspect; (b) angular extent of target - a function of range and target; and (c) spectral content and dispension - a function of target and particular missile seekers. The infrared target source should simulate a realistic target to within a range of 1000 feet in a chamber with a missile seeker-to-target source distance of 20 feet.

N87-215. TITLE: Automated Best Source Selector

CATEGORY: Engineering Development

DESCRIPTION: Higher telemetry data rates, greater missile ranges and dynamics, and the increase in interfering frequencies of modern weapons testing, greatly increase the need for space diversity to ensure telemetry data. Space diversity is achieved through the use of multiple telemetry receive sites. Currently the PMTC Realtime Data Collection Facility receives and records data from up to 6 sources, and the best source is manually selected. Data is frequently lost in the reaction or faulty judgment of the operator responsible for switching. An automated best source selector is required to accept digital data inputs from up to 6 sources, time align the data, and output one digital data stream which is the "best" of the received data. A form of combining would be developed to eliminate switching, with the potential of providing signal enhancement beyond that of the best signal alone. This project is high risk, since no known manufacturer has designed such a device. It has high potential use due to minimizing data loss and increasing data quality for realtime recording, processing, and display. The application would be to most missile and aircraft test ranges using multiple telemetry receive sites.

N87-216. TITLE: Multipoint Target Radio Frequency Augmentation

CATEGORY: Advanced Development

DESCRIPTION: An augmentation method to make small missile-type targets have the distributed multipoint radar signatures of physically large fighter bomber and bomber targets is required by the test and evaluation community. The multipoint augmetor should provide fade, glint, scintillation and angle noise typical of large targets by generating multiple RF sources and wave fronts from extended points on the target. The augmentation may be a number of small (subscale) corner reflectors for passive enhancement or a Traveling Wave Tube (TWT) or solid state

amplifier with multiple transmit horns, and phase and amplitude modulators. General specifications are:

Coverage	+60° off nose or tail
Frequency	9.0 GHz to 10.3 GHz
Augmentation	1 sqm to 15 sqm
Altitude	0.1 KFT to 90 KFT
Mach	0.9 at 0.1 KFT to 25 KFT, increase to 1.8 at 45 KFT and to 3.0 at 70 KFT.

N87-217. TITLE: Head Attitude Sensor

CATEGORY: Advanced Development

DESCRIPTION: A system capable of measuring the pointing direction of a pilot/trainee's head relative to the cockpit is required for a head coupled display system being developed for a flight training simulator. The required performance is an accuracy of 1/2 minute of arc in pitch, azimuth, and roll anywhere within 240 degrees azimuth and +90 to -60 degrees in pitch relative to the forward direction of the cockpit. Since the pilot's head is free to move in any direction, systems which restrict head movement, either in position or orientation, are not suitable. Another performance requirement is a response time which must be less than 10 milliseconds and preferably less than 5 milliseconds. If the system samples, the sample rate must be at least 120 Hz and preferably 240 Hz, or better.

N87-218. TITLE: Implementation Of ADA On Distributed Microprocessor Computer Architectures For Aircrew Training Systems

CATEGORY: Engineering Development

DESCRIPTION: Distributed microprocessor computer architectures will be utilized in aircrew training systems in the near future due to their reduced acquisition costs and improved life cycle supportability characteristics. To realize the full potential of this approach and to comply with DOD requirements, it will be necessary to use the Ada programming language. Ada is a very comprehensive and complex language with is intended to force better programming techniques, make software more easily modifiable and reuseable, and reduce life cycle costs. Relatively little is known about real-time tasking in Ada and its associated problems. There is a very real potential that this feature may be difficult, or impossible, to apply in complex real-time aircrew simulation applications. The scope of the Phase I effort is to develop a plan for implementing and evaluating Ada as the software language on major training systems acquisitions which incorporate distributed microprocessors as the simulation system. The plan will outline the research issues, advantages/disadvantages to implementation, alternative approaches, and critical path elements.

N87-219. TITLE: Remotely Piloted Vehicle (RPV) Training System

CATEGORY: Management & Support

DESCRIPTION: Because of its relative low cost, high survivability based on small size, inherent flexibility, and state-of-the-art technology, the remotely piloted vehicle (RPV) has become more attractive for expanded military applications. RPV's can significantly lower cost in equipment and personnel loss and are being introduced into military operations with increasing regularity. A need exists for the development of a training system that will improve skill retention and performance to acceptable levels of military operational readiness without any attendant loss of actual RPV systems. This system must be a deployable RPV trainer that can be used at forward based sites as well as aboard ship to provide the training and overlearning required to retain RPV control skills. The system should not only have an accurate aerodynamic simulation model of the RPV but must also provide diagnostic feedback for the student.

N87-220. TITLE: Computer-Based Item Pools Evaluation Software

CATEGORY: Advanced Development

DESCRIPTION: The measurement precision of an ability test can be degraded when the test taker is asked questions that are very similar, essentially equivalent, or not independent of previously asked questions. With paper-and-pencil tests, this can be prevented with an easily-performed manual comparison of the items on the printed booklet. However, this task becomes substantial when the number of questions to be checked is large, as is the case in the item pools required for computerized adaptive testing. Emphasis should thus be on developing and delivering a computer program to automate item-pool checking in the Navy-developed tri-service computerized adaptive testing system.

N87-221. TITLE: Assessing Effectiveness Of A Functional-Work-Context In Training

CATEGORY: Management & Support

DESCRIPTION: Universally, military technicians in electrical and electronics occupations are trained in a curriculum that begins with instruction in the basic concepts and physical laws of electricity. The courses are taught in large numbers (25,000 in the Navy alone), are abstract/academic in nature, have high attrition, and provide imperfect basic knowledge as a basis for further training or for follow-on jobs. A system was developed for designing a functional-work-context for training basic knowledge and skill. It calls for designing an interactive setting, work-like in character, in which the student learns to use the appropriate concepts and vocabulary, perform the appropriate procedures, make predictions and solve representative problems. The setting is tailored both to the student's level of understanding and knowledge, and to representative work requirements. The advantage of the system is that what students learn should be more useful in subsequent training or in carrying out job functions. This

needs to be tested. It is proposed that this system be used to develop a functional-work-context course in basic electricity, and that the quality of student learning assessed. The deliverable is 60 hours of training materials for the Direct Current portion of the Basic Electricity and Electronics curriculum that are developed in accordance with the functional-work-context approach.

N87-222. TITLE: Chemical, Biological, And Radiological Defense Training

CATEGORY: Management & Support

DESCRIPTION: Actual or threatened chemical, biological and radiological-defense conditions impose severe limitations on the capability of military personnel to perform essential operations, such as communications, emergency maintenance, damage control, and other critical tasks. Critical tasks most vulnerable to perform degradation under chemical, biological, and radiological-defense conditions have been identified. To overcome this performance loss, this present effort proposes evaluation of various training interventions or job aids, including the possibility of equipping individuals with strategies or alternative means of performing the essential tasks associated with their jobs. The deliverable is a report on the results of researching the human factors of performing critical tasks with recommendations regarding training and aiding interventions.

N87-223. TITLE: Synthetic Line Hardware

CATEGORY: Advanced Development

DESCRIPTION: Synthetic lines are widely used in marine applications because they are lightweight, corrosion-resistant, easy to handle and have relatively high strength-weight ratio. They are found on Navy vessels as mooring lines, lifting lines, guys, stays and tow lines to name a few uses. Deficiencies in the current applications are in part caused by deficiencies in associated hardware (terminations, linkages, etc). These deficiencies also limit the potential of synthetic line for a wider range of Navy applications. The current techniques and hardware used with synthetic lines were adapted from wire rope technology. As a result, the associated hardware is heavy and is usually the weak link in the line system because the differences in mechanical properties between steel wires and synthetic fibers have not been adequately addressed. Handling this hardware, which can weigh over 300 pounds is both difficult and hazardous. In addition, corrosion of metallic end fittings is a major problem. One viable alternative is to use synthetics. There is a need for high-strength, lightweight line handling hardware, synthetic sheaves, quick release stoppers, shackles and thimbles of composite materials, e.g., kevlar reinforced plastics. Development of materials and fabrication technology are needed.

N87-224. TITLE: Ground Penetrating Radar

CATEGORY: Advanced Development

DESCRIPTION: A ground penetrating radar (GPR) system is needed to locate underground utility lines and other manmade and naturally occurring objects (Metallic and Non-Metallic) in the ground profile to 20 feet. A detection rate of better than 90% under all ground profile conditions is required. This includes high water table conditions.

N87-225. TITLE: Non-Metallic Steam Line Jackets

CATEGORY: Advanced Development

The Navy waterfront has many miles of underpier and underground steam lines. These lines suffer from a highly corrosive environment caused by high water tables and high sea levels. Jacketed steam lines eventually allow water penetration that accelerates corrosion, insulation breakdown, and massive heat losses. Underpier steam lines additionally experience abuse from wave activity and floating debris. A jacket material is required that has no seams, is non-corrosive, retrofittable, withstands abuse of installation and impact of waves and floating objects, and retains long life integrity.

N87-226. TITLE: Reduced Diameter Centrifugal Impeller Diffuser Investigation

CATEGORY: Engineering Development

DESCRIPTION: With the development of the axial compressor, the centrifugal compressor with its large diameter and lower efficiency was used less. Recently engine designs with axial/centrifugal configurations have been used. The centrifugal stage replaces several axial stages (small blades) but still has a larger diameter than an all axial machine. The centrifugal impeller is more rugged than axial blading and has a better stall margin capability. The area of the centrifugal compressor that must be investigated is the diffuser. With improved efficiency and a reduced diameter the centrifugal stage can be competitive with axial stages. The payoff will be fewer parts that are more durable and operable for application to patrol and possibly multimission fighter attack type aircraft.

N87-227. TITLE: Expert System For Directing Propulsion Technology

CATEGORY: Management & Support

DESCRIPTION: Two areas of experience exist regarding aircraft gas turbine engine technology. The first is the component expert who has many years of experience and is thoroughly knowledgeable in a particular engine component area. The second is the personnel who work close to the operational equipment and are knowledgeable regarding past and current engine problems. The purpose of this development is to capture the knowledge base of these experienced personnel and incorporate this knowledge into an expert system. This expert system will identify

exploitable technology areas which will eliminate the carryover of current problems into future engine systems.

N87-228. TITLE: Ceramic Development For Aircraft Engines

CATEGORY: Exploratory Development

DESCRIPTION: Develop ceramic components or coatings for high temperature gas turbine engines. The objective is to reduce turbine cooling air requirements, improve life, reduce cost of future gas turbine engine components. The components or coatings must meet future engine life requirements.

N87-229. TITLE: Aircraft Engine Turbine Instrumentation

CATEGORY: Advanced Development

DESCRIPTION: Develop non-intrusive, durable instrumentation to measure turbine temperature, pressure and stress at turbine inlet, interstage and exit locations. The objective is to develop this instrumentation to provide analytical, diagnostic and monitoring data to determine turbine health and performance.

N87-230. TITLE: Radiative Ignition And Combustion Enhancement

CATEGORY: Advanced Development

DESCRIPTION: Future Navy aircraft propulsion system missions put severe strains on conventional spark ignition combustion systems relying on recirculation zones or bluff bodies for flame stabilization. The use of radiative sources should be investigated as a potential technique for extending aircraft operating limits associated with combustion processes. The proposed program would be analytical and/or experimental. Potential payoffs to Navy propulsion systems include improved altitude relight, potentially shorter combustion systems, enhanced operations on alternative/high density fuels, and the development of zero-drag flame holders.

N87-231. TITLE: Turbine Engine Damage Resistance Technology

CATEGORY: Engineering Development

DESCRIPTION: The vast majority of unscheduled engine removals to Navy turbofan/turbojet powered aircraft are caused by Foreign Object Damage (FOD). Typical FOD consists of stones, safety wire, NO-SKID (carrier deck surface), ice, aircraft fasteners and fairing. The first stages of the fan section (blades and stators) sustain the heaviest damage. In particular, the leading edges of these blades and stators become dinged and notched resulting in aerodynamic losses and additional damage to successive compressor stages. The repair and/or replacement of these damaged parts have a significant impact on readiness, logistics support costs and manpower. Currently, the only way to inhibit the FOD problem is to thicken the leading edges of fan blades and stators. This addi-

tional material adds weight to the engine and is aerodynamically inefficient. In order to avoid thick airfoil leading edges and attendant aerodynamic losses, we need to develop a protective coating or leading edge treatment for fan blades and stators. This coating or leading edge treatment for fan blades and stators. This coating or leading edge treatment will have the capability to absorb the impact energy or deflect small foreign objects ingested by high performance fans and compressors. This technology will be essential for application of high efficiency, low weight blisks for Navy turbofan/turboshaft engines.

N87-232. TITLE: Repair Of J-52 Bolt Hole Low Cycle Fatigue Damage

CATEGORY: Engineering Development

DESCRIPTION: Each year the Navy retires an estimated 50-100 million dollars worth of aircraft engine disks from service because they have reached the life limit set by the manufacturer. In some cases, such as the J-52, disks are being removed only when cracked. However, in both cases there is enormous payback to be achieved (e.g. 10:1) if the bolt holes could be reworked using conventional metalworking techniques such as cold expansion. This process has been used successfully on fastener holes of fuselage sections of F-18 aircraft to increase fatigue life 3 X with with no reported failures. Using a split sleeve cold expansion process, fatigue critical holes are expanded into a state of high residual compressive stress with no metallurgical changes. This process could be applied to compressor disks using an insert bushing and similar cold expansion techniques. Such a process is needed on J-52 disks because of a critical shortage of parts and the long lead times required in the procurement of new disks. The savings in maintenance dollars for disks could be reduced by an order of magnitude since for each unit of disk repair cost, there are 10 units of disk savings. Restoring the fatigue life of used disks is 6 X quicker than making a new disk. Therefore, fleet readiness is greatly improved.

N87-233. TITLE: Noise Supressor Development

CATEGORY: Advanced Development

DESCRIPTION: Develop a noise suppressor for pneumatic quiet valves and air pressure reduction manifold stations in submarines using innovative fluid dynamic/acoustical techniques to provide a counterpoint (alternate sources) for the existing technology developed in the 1970s. Required to insure quiet operating conditions.

N87-234. TITLE: Submarine Structural Model

CATEGORY: Exploratory Development

DESCRIPTION: Develop analytical model for submarine structureborne vibration due to active sonar operation. Model is urgently needed in order to predict noise in new and advanced submarines.

N87-235. TITLE: Waterside Security Robotics

CATEGORY: Engineering Development

DESCRIPTION: The objective is to develop a conceptual robotic system for the detection, assessment, and response of waterborne intrusions. The required mechanical, electrical, and control system characteristics of the bionically enhanced vehicle must be determined. The feasibility and cost benefits of the underwater security robot must also be evaluated. The timely detection, assessment, and response to a waterborne intruder (i.e., swimmer or scuba diver) is essential to ensure the security of waterside facilities and their associated high value assets. An underwater robotic vehicle with bionic sensors, such as broadban sonar, bianural hearing, and stereovision, will combine the conventionally separate operations of intruder detection, assessment, and response into a single waterside security system. An underwater robot is needed to carry the bionic sensors and to provide the necessary speed and mobility for waterside security operations.

N87-236. TITLE: High Pressure Optical Penetrator For Single Mode Fiber

CATEGORY: Engineering Development

DESCRIPTION: Develop a penetrator capable of accepting a dematable fiber which can withstand pressure differrentials of 10,000 psi and operated reliably with multiple connect/disconnect cycles.

N87-237. TITLE: Optical Slip-Ring For Single Mode Fiber

CATEGORY: Advanced Development

DESCRIPTION: Use of cables with single mode optical fiber data transmission elements is not presently feasible using existing winch rotary joints. A rotary joint must be developed to transmit optical signals with minimal attenuation.

N87-238. TITLE: Undersea Visibility Condition Monitor

CATEGORY: Advanced Development

DESCRIPTION: A problem in the development of undersea systems which operate visually is to quantify performance of the system as a function of the visibility conditions. The specific parameters of interest when characterizing the visibility conditions are the light level and turbidity. A high performance underwater visual system which is in advanced development has a requirement to generate performance curves and to find the system limits as a function of turbidity and light level. A small, rugged instrument package is required to measure these parameters. This instrument must be able to measure illuminance in the range between 10 and 10 foot-candles for wavelengths between 400 and 700 nanometers. It is also must be able to measure turbidity between 0 and

100% transmission/10 cm, and be able to indicate the depth at which these other parameters are measured. this instrument must be highly portable, battery powered and able to operate from a 22-foot Boston Whaler boat.

N87-239. TITLE: Teleoperator Feedback Systems

CATEGORY: Advanced Development

DESCRIPTION: The improvement and increased reliability of teleoperator systems necessary to produce man-like dexterous performance requires the development of advanced end-effector sensors and displays, as well as advance in actuator or end-effector devices capable of exerting forces with the same efficiency as a man's hand and fingers. Some of the issues associated with the display of end-effector sensor information can be resolved through the development of models and methods to stimulate the somatosensory system of the operator. Problem areas which need to be explored include the type to sensors and displays necessary to produce sensations of object apprehension, (i.e., the realization of structural, surface and functional properties of objects).

N87-240. TITLE: Develop Permeable Membrane Compressed Air Dehydrator

CATEGORY: Advanced Development

DESCRIPTION: Develop a thin-film permeable membrane/material and support composite optimized for removing water vapor from a shipboard compressed air stream. Design and fabricate a suitable module, incorporating this membrane technology, for evaluation by DTNSRDC. Design Conditions are as follows:

Inlet Pressure 80-125 psig
Inlet Temperatures 50 to 122°F
Inlet Humidity saturated at pressure and temperature
Outlet humidity -40°F dwpoint

The module should be sized for a minimum capacity of 5 standard cubic feet per minute. The module shall be capable of 85% efficiency, that is 85% of the volume entering shall leave as product air at -40°F dewpoint.

N87-241. TITLE: Oxygen Generation Utilizing Non-Cryogenic Processes

CATEGORY: Advanced Development

DESCRIPTION: Small quantities of oxygen at 1800-2300 psia are used on naval surface vessels for emergency life support purposes. Non-cryogenic processes capable of producing 10-20 lb/hr of oxygen meeting the purity requirements of MIL-O-27210 are of interest. Proposals for the oxygen generation process, the oxygen pressurizer or for both will be considered.

N87-242. TITLE: Novel Method Of Filtration For Reverse Osmosis Pretreatment

CATEGORY: Advanced Development

DESCRIPTION: Reverse Osmosis Prefiltration System. Navy reverse osmosis (RO) desalination systems utilize a diatomaceous earth filter for pretreatment in order to prevent particulate and biological fouling of the membrane. There would be considerable interest in identifying new methods of filtration which could result in improved filtrate quality, reduced system size and complexity, and reduced system maintenance requirements. Proposers are requested to propose (1) new method(s) of filtration for RO application and (2) a program to evaluate the feasibility of the concept for shipboard RO desalination.

N87-243. TITLE: Reverse Osmosis Membrane Development

CATEGORY: Exploratory Development

DESCRIPTION: Reverse Osmosis Membrane Development. The Navy has developed a reverse osmosis (RO) desalination system for shipboard desalination. RO membranes (which are incorporated in a modular configuration) are susceptible to degradation by (1) oxidizing agents used to control biofouling and (2) fouling by suspended solids. A membrane less vulnerable to these threats would improve RO plant reliability and potentially reduce overall system costs. Persons knowledgeable in membrane/polymer development would be encouraged to submit proposals on the development of a membrane resistant to oxidizing agents and foulants.

N87-244. TITLE: Freon Absorption Air Conditioning

CATEGORY: Engineering Development

DESCRIPTION: Investigate recent developments in commercial freon based absorption air conditioning technology for potential application to naval ships. Determine state-of-the-art parameters such as weight/space/power requirements per ton of cooling and assess environmental hazards, reliability, safety, and complexity. Prepare report.

N87-245. TITLE: Mixed Refrigerant Application To Shipboard Air Conditioning

CATEGORY: Advanced Development

DESCRIPTION: Investigate mixed refrigerants for applications to naval shipboard air conditioning. Determine optimum mixture combinations. Assess heat exchanger performance with widely varying loads (10% - 100% capacity) and widely varying condensing conditions (seawater temperature from 28°F - 95°F). Investigate control strategies and systems for optimizing mixture at off-design conditions. Investigate methods for determination of mixture and prepare report.

N87-246. TITLE: A Comprehensive Model For Robotic Applications

CATEGORY: Advanced Development

DESCRIPTION: The contractor shall develop a comprehensive model for identifying military logistics applications for robots. The literature contains many good but limited robotic models, which shall be reviewed and incorporated into the comprehensive model. These past-models are limited in the sense that they relate only to some dimensions, such as robot capabilities, and not to others such as justification of robots on the basis of safety, labor savings, reducing boredom, or other considerations. As a minimum, the model shall include descriptions of: robot capabilities, justification of robots, robot tasks (e.g., welding, etc), and frequency of current applications. The model shall also identify applications that may not satisfy all robot criteria (e.g., teleoperated robots are of interest even if they are not reprogrammable).

N87-247. TITLE: Robot Performance Considerations In Naval Environments

CATEGORY: Exploratory Development

DESCRIPTION: This effort will consist of identifying Naval environmental factors relevant to the performance of industrial style robots. Considerations will include: ship motion, corrosion, ship vibration, space limitations, wetness, etc. The effects on performance of these and other factors will be studied (analytically where possible) and possible solutions proposed.

N87-248. TITLE: Composite Piping Systems

CATEGORY: Advanced Development

DESCRIPTION: Develop improved composite materials and processes to extend the capability of composite piping systems. Properties requiring upgrading include: (a) Impact resistance - tougher resin/glass systems; (b) Higher temperature service - high temperature adhesive systems; (c) Fire/smoke/toxicity - improve performance of existing materials and products; and (d) Conductive resin systems and adhesives to allow use on fuel piping. The work should include evaluation and demonstration of improved capability.

N87-249. TITLE: Weapons Launch

CATEGORY: Exploratory Development

DESCRIPTION: Develop a concept for launch of submarine weapons. Concept must be appropriate for post-SSN-21 class submarine (2010 or later). The Phase I study should include the selection of a concept to be developed by considering potential impact/interfaces of alternative concepts on a submarine including arrangement, weight, space, power required, ability to launch at high speeds without weapon damage and ability to launch covertly.

N87-250. TITLE: Fast Optical Switch For Multimode Fiber Optics Applications

CATEGORY: Engineering Development

DESCRIPTION: There are signal processing functions that could be more efficiently performed by optics than electronics if the appropriate switches were available. Unfortunately, current optical switch technology provides switching speeds on the order of 10 milliseconds for commercially available mechanical switches to 100 picoseconds for single-mode laboratory switches and nothing in between. The objective of this development effort is to design and fabricate a single-pole, double-throw multimode optical switch that can be actuated in less than 1 microsecond and interfaced to popular logic circuitry such as TTL or ECL.

N87-251. TITLE: Autonomous Target Identification

CATEGORY: Exploratory Development

DESCRIPTION: Develop innovative approaches and new techniques for autonomous target recognition and identification. Advanced missile seekers and targeting systems will require autonomous target identification capability to improve effectiveness and survivability, and to decrease pilot workload, respectively. Such capability requires the development of target identification algorithms for potential use with sensors such as visible, infrared, radar, or multiple sensors, etc. The objective of this effort is to propose and sufficiently develop candidate algorithms to demonstrate their expected performance through computer simulation against target imagery. Since the proposed algorithms will be ultimately implemented in a size/weight/volume compatible with aircraft/missile avionics, an estimate of hardware/software implementation requirements and cost shall be made for the candidate algorithms.

N87-252. TITLE: Data Acquisition System For Infrared Thermography

CATEGORY: Engineering Development

DESCRIPTION : To analyze engine generated hot gas flow patterns, an AGA-780 thermovision infrared system is used. The analysis is restricted to real time because no method exists to record the full dynamic range of the video signal for post-test analysis. A record of limited steady state quantitative data is produced, but data from transient events are missed. Acquiring the thermal imagery data in a real time mode requires recording the raw data directly from the infrared camera. The analog signal varies from 0 to 10 volts at frequencies of DC to 80K Hz with a 48 dB S/N ratio required for maximum resolution at playback. There is a requirement to develop a data acquisition system for this data.

N87-253. TITLE: Resource Allocation Model

CATEGORY: Management and Support

DESCRIPTION: A requirement exists for the development of a computer model for use in resource allocation decision making in the research, development, test and evaluation environment. The model must deal with existing resources, existing and prospective workloads and varied funding scenarios. User friendliness and ability to run on commonly available microcomputers are important parameters.

N87-254. TITLE: Compact Communication Simulation Equipment

CATEGORY: Advanced Development

DESCRIPTION: There is a need to develop innovative approaches to the problem of providing a large quantity of simulated communications signals for the test and evaluation of equipment to be installed in confined spaces. Evaluation of communications/electronic warfare equipment requires exposing the systems under evaluation to a large quantity of controlled signals. Signals of interest include clear voice, secure voice, command control signals, data link/nets, etc., of all modulation types. Realistic battlefield signal densities of 1,000 to 2,000 simultaneous signals are required. Emphasis is to be placed on obtaining maximum signal density with the smallest possible equipment size. Frequencies include HF, VHF, UHF and Microwave bands. All signals need to be computer controllable and to be generated at the radio frequencies.

N87-255. TITLE: Digital Filtering And Smoothing

CATEGORY: Engineering Development

DESCRIPTION: Many test and evaluation tools and techniques require data filtering and smoothing and the derivation of rates. Data sources include radars, cine-theodolites, laser theodolites, fixed airborne and ground cameras, and aircraft sensor data. These data are utilized in such tests as weapon delivery accuracy, carrier takeoff and landing, store separation, ballistics, flying qualities and performance, etc. A classical least square moving arc polynomial technique has been utilized for data smoothing and rate determination. While this technique is reliable for some applications, it does not lend itself to real-time applications or applications such as a carrier landing where an abrupt landing influences the smoothing of data points several time samples previous. A requirement exists to develop techniques and software for optimal smoothing and rate determination for both real-time and post flight considerations.

N87-256. TITLE: Search Sensor Innovation

CATEGORY: Exploratory Development

DESCRIPTION: Conduct a study to develop new and innovative ideas/concepts for a long range Airborne Early Warining search sensor

not of the conventional radar type, and for utilization in lighter-than air platforms. There is continuing effort to innovate in the area of sensor ideas/concepts. The reintroduction of the concept of utilizing lighter-than-air platforms for Airborne Early Warning could precipitate development of sensors not of the conventional radar type. There is a need to investigate and determine the test and evaluation implications and requirements that such new sensors might foster. Infrared, electronics, electromagnetics and any other applicable sensor technologies should be considered.

N87-257. TITLE: <u>A High Resolution, Low Altitude Flight Test Anemometer Ground Station For Helicopter And Vertical Take Off And Landing Aircraft Testing</u>

CATEGORY: Engineering Development

DESCRIPTION: The need to identify ambient wind conditions for flight testing of helicopters and other VTOL aircraft is made more difficult by the influence of high-velocity jet exhausts and rotor wakes on the local air mass motion under light to moderate wind conditions and in the presence or the ground boundary layer. The objective of this study is to identify the equipment needs and analysis techniques that will provide an accurate measure of ambient wind conditions for altitudes below 100 feet above the ground surface. The system should provide a permanent record of the mean velocity vector and some measure of the unsteady velocity as a function of altitude. Time synchronization with aircraft test data should be provided. Portability, to allow remote site testing and to minimize airfield obstruction when not in use, is important. Identification of component accuracies, frequency response (or response distance) and number of sensors should be addressed.

N87-258. TITLE: <u>Compact Dynamometer For Turboshaft Engines</u>

CATEGORY: Advanced Development

DESCRIPTION: Performance testing of turboshaft engines requires the use of large and enormously expensive dynamometer or club propeller test cells. A compact steam generating dynamometer could effect significant savings and efficiencies. It could be of a portable configuration which could enable on-wing testing of engines for P-3, C-130, E-2, and V-22 aircraft, as well as on-the-aircraft testing of helicopter engines. This requirement is for the exploration of the applicability of existing steam generating dynamometer designs to the T-56-427 engine and the development of a proposed configuration of a prototype model.

N87-259. TITLE: <u>Optical Design Innovations For Aircrew Display And Test Devices</u>

CATEGORY: Advanced Development

DESCRIPTION: Develop and demonstrate improved optical mirror-beamsplitter devices for use with head-up displays, helmet mounted

displays and short relief non-helmet mounted displays. Innovations should capitalize on improved materials and coatings (including plastic optics), on improved design and component selection, manufacturing and acceptance testing techniques, and on other innovations for the development of conventional optics (reflective and refractive) for these special applications. Since display devices themselves are not an element of this effort, all demonstrations may be made with static imagery, such as photographic transparencies. The goal of the effort is to enable development of new configurations for aircrew displays requiring virtual image optics. Advances will also improve certain other combined devices, such as test equipment for eye tracking, by making it possible to fit them within the limited eye relief space of present night vision goggles, face protective visors or masks and eyeglasses. The innovations sought will streamline design practices and improve size, weight, cost, durability and performance of these devices.

N87-260. TITLE: Plane Wave Generation

CATEGORY: Advanced Development

DESCRIPTION: Develop innovative approaches to provide plane waves at radio frequencies within a confined space. Modern testing of electronic warfare (EW) equipment includes testing of receivers in anechoic chambers. The generation of plane wavefronts is important when evaluating systems with interferometer type antenna systems but difficult when dealing with limited size chanbers of approximately 60 feet by 90 feet. Maximum separation of the source to the system under test is 20 to 30 feet. The systems vary in aperature size; and the frequency of interest is from 0.5 to 100 GHz. The source needs to provide a means of controlling the direction of emanation for full evaluation of systems.

N87-261. TITLE: Extended Flight Analysis

CATEGORY: Exploratory Development

DESCRIPTION: Currently under investigation are Airborne Early Warning missions requiring extended flights. The duration of these flights may extend from several days to several weeks. Crew sizes might range from twelve to twenty-four persons, and crew members will be required to perform many functions, including operation and maintenance. Crew related technical and human factors issues concerning these extended flights need to be identified, cataloged and studied. Relevant historical data must be collected and analyzed. Problems and solutions in similar environments should be evaluated for applicability. Proposed methodologies for the formulation of solutions to anticipated problems need to be developed.

N87-262. TITLE: Helmet Mounted Occulometer

CATEGORY: Engineering Development

DESCRIPTION: As a part of a data acquisition system for the monitoring

of visual gaze point, a requirement exists for a helmet mounted occulometer which will be lightweight, flightworthy, self-calibrating and operable in a variety of lighting conditions. It should be capable of operating with night vision goggles and/or helmet display devices. Outputs should include digital eye movement records and a machine scoreable record of eye location suitable for summary statistics for analysis. The requirement is for the design and development of such an occulometer which will lead to the production of a prototype.

N87-263.* TITLE: Research Instrumentation Based On New Measurement Techniques

CATEGORY: Exploratory Development

DESCRIPTION: Progress in scientific and engineering research is becoming more dependent on the availability of instrumentation incorporating new physical measurement techniques. Examples of recent promising developments or evident future needs include sophisticated acoustic sensing techniques, the scanning tunnelling electron microscope, "smart" chemical microsensors for detection and analysis, fiber-optic based systems, automated instruments to speed measurements and to provide processed information (rather than raw data), stable picosecond pulse generators, non-destructive test and evaluation apparatus, laser measurements of fluid flow, and many others. The timely development of new instrumentation based on new sophisticated measurement techniques now being developed at university and other research laboratories would make advanced measurement techniques more widely available thru commercial instrumentation and thus could be of great benefit to the defense research effort. Small businesses which can demonstrate knowledge and understanding of modern scientific measurement techniques are requested to submit proposals to develop instruments utilizing these latest techniques.

*Proposals for topic N87-263 should be mailed to Office of Naval Research (see information listed for topics N87-1 through N87-9).

AIR FORCE

Proposal Submission

The responsibility for the implementation and management of the Air Force SBIR program is with the Air Force Systems Command Deputy Chief of Staff for Science and Technology. The Air Force SBIR program manager is Mr James R. Meeker. Inquiries of a general nature or where a problem may exist requiring the AF SBIR program manager's attention should be sent to:

Department of the Air Force
HQ AFSC/DLSR (Mr. J. R. Meeker)
Andrews AFB DC 20334-5000

Under no circumstance shall a SBIR proposal be submitted to the above.

Five (5) copies of each Phase I topic proposal shall be addressed to office as designated in the following:

AF87-001 thru AF87-020	AD/PMR Building 350, Room 428 Eglin AFB FL 32542-5000
AF87-021 thru AF87-027	AEDC/DOT Building 1099 Mail Stop 900 Arnold AFS TN 37389-5000
AF87-028 thru AF87-036	ESD/XR-1 SBIR Program Manager Brown Building Hanscom AFB MA 01731-5000
AF87-037 thru AF87-065	RADC/XPX (ATTN: Mr. B. M. Donovan) Griffiss AFB NY 13441-5700
AF87-066 thru AF87-072	HQ AFESC/RDXP Building 1120 Tyndall AFB FL 32403

AF87-073 thru AF87-090	HQ Aerospace Medical Division AMD/RDO (ATTN: Ms B. Williams) Building 150, Room 224 Brooks AFB TX 78235-5000
AF87-091 thru AF87-108	AFWAL/GLXPM Area "B" Building 653 Room 406 Wright-Patterson AFB OH 45433-6533
AF87-109 thru AF87-123	AFWAL/GLXPF Area "B" Building 45, Room 149 Wright-Patterson AFB OH 45433-6553
AF87-124 thru AF87-139	AFWAL/GLXPP Program Group Building 18A, Room A-103 Wright-Patterson AFB OH 45433-6563
AF87-140 thru AF87-157	AFWAL/GLXPA Avionics Program Office Building 22, Room S-110 Wright-Patterson AFB OH 45433-6543
AF87-158 thru AF87-159	ASD/AEE Special Assistant for Program Coordination Building 57/Bay 5 Wright-Patterson AFB OH 45433-6503
AF87-160 thru AF87-165	ASD/XRX Director of Planning Strategy Building 11A, Room 201 Wright-Patterson AFB OH 45433-6503
AF87-166 thru AF87-178	AFSTC/OLAB PO Box 92960 Los Angeles AFS CA 90009-2960

AF87-179 thru AF87-180	HQ AFSTC/XN ATTN: Lt Steele Building 497, Room 205 Kirtland AFB NM 87117-6008
AF87-181 thru AF87-184	AFGL/XOP Building 1107, Room 229 Hanscom AFB MA 01731-5000
AF87-185 thru AF87-192	AFRPL/TSTR Building 8252, Room 12 Edwards AFB CA 93523-5000
AF87-193 thru AF87-200	AFWL/PRC Building 413, Room 282 Kirtland AFB NM 87117-6008
AF87-201 thru AF87-240	BMO/MYSC Building 523, Room 302 Norton AFB CA 92409-6468
AF87-241	AFOSR/XOT Building 410, Room A-113 Bolling AFB Washington DC 20332-5000

AF87-001. TITLE: Armament Research

OBJECTIVE: To develop new and innovative ideas/concepts and analysis methodologies in the area of non-nuclear munitions and armaments.

DESCRIPTION: New and innovative ideas/concepts and analysis methodologies are desired in the area of non-nuclear munitions and armaments. These include explosives, energy sources and conversions, bombs, submunitions, warheads, fuzes, dispensers, guns, rockets, ammunition, ammunition feed systems, sensors and seekers, explosives, propellants, carriage and release equipment, aerodynamic and structural technologies, tactical missile guidance and control technologies, exterior ballistics, analysis, and lethality and vulnerability assessment techniques. Some examples of desired research are low drag/observable weapon airframes, conformal ejector racks, integrated fuzing, millimeter wave seekers/sensors for midcourse and terminal guidance, heavy metal self-forging fragment warheads, heavy metal shaped charges, long rod penetrators, reactive fragment warheads, and Computational Fluid Dynamics.

AF87-002. TITLE: Bomb Terminal Guidance

OBJECTIVE: To determine the characteristics and specifications of terminal seekers, their costs and applicable targets for future use with weapons equipped with low cost inertial guidance.

DESCRIPTION: The Air Force Armament Division (AD) is currently entering into a program to demonstrate low cost inertial guidance applied to unguided bombs. The accuracy on target of bombs equipped with this low cost inertial system is expected to be improved by an order of magnitude or better depending upon the launch conditions. The program is called the Inertial Guidance Technology Demonstration (IGTD).

For point targets or hard targets one still needs Precision Guided Munitions (PGMs). The accuracy of the IGTD weapon will allow the use of a small field of view, strapdown terminal seeker permitting attack of a certain class of targets with very small CEPs. The seeker and associated electronics must be low cost in order to consider any future use.

AF87-003. TITLE: Microstrip Phased Array Millimeter Wave Radar Antenna

OBJECTIVES: To investigate the potential of developing a microstrip phased-array millimeter wave antenna.

DESCRIPTION: The Air Force is in need of "Brilliant Weapon" radar guided missile technology for both air-to-ground and air-to-air missiles. This entails the need for radar seekers that are small, low cost, lightweight, yet have a high power output. One of the components, which can advance the state-of-the-art in radar missile guidance technology, is in the area of the antenna. By using a phased-array antenna the gimbal can be eliminated, thereby saving space and weight in the missile. Additionally, elimination of

the gimbal reduces the hardware needed in front of the warhead, allowing the warhead to operate against the target with less obstructions, and making a microstrip antenna reduces the weight of the antenna itself.

This program will concentrate on the design of a phased-array antenna, as well as developing microstrip techniques. It should have a +20 degrees steering capability in azimuth with a scan rate of 40 degrees per second. It should be capable of handling 100 watts of output power. The antenna should be developed for a missile which has approximately 12-15 inch diameter body shell.

AF87-004 TITLE: Monopulse Optics for Radar

OBJECTIVE: To investigate the potential of using optics to replace monopulse waveguide feed networks.

DESCRIPTION: The Air Force has a need for "Brilliant Weapon" radar guided missiles for air-to-air and air-to-ground applications. It is a major objective to make these radars more powerful, have greater target detection capability, operate in high clutter environment and yet be small and have low power requirements. This effort is to take one aspect of the radar and attempt to microminiaturize it. When attempting to identify targets, the polarization of the return signal is invaluable. For tracking targets a radar must be able to determine the direction of the target relative to where the antenna is pointing. This can be done by several techniques. The most popular is monopulse where the angular error is obtained on the basis of a single pulse. However, the feed networks required for waveguide monopulse can be complicated, large and lossy. Using optics to miniaturize and simplify the waveguide network should reduce the losses and ease the complexity of the system.

This program shall investigate the potential of using optics to replace monopulse waveguide feed networks. A cluster of four feeds is necessary to obtain both elevation and azimuth error signals. It should be able to handle approximately 100 watts of transmit power through the sum channel. The optical monopulse system should provide high efficiency, compactness, be simple and lightweight, have low losses, provide low aperture blockage, and have excellent boresight stability independent of frequency. An additional area of interest is the separation of the polarization received signal. It should be constructed to handle millimeter wave frequencies.

AF87-005. TITLE: Real-time Optical Fast Fourier Transform (FFT)/Computers

OBJECTIVE: To examine the capability of using real-time optical fast Fourier transform/computer for processing radar data such as that from synthetic aperture radar.

DESCRIPTION: There is a need in the Air Force for "Brilliant Weapons" radar to guide missiles in both air-to-ground and air-to-air applications. These radars must be powerful, yet small, compact, and lightweight. One aspect of the radar which can be redesigned to meet those requirements is to examine

the capability of using realtime optical fast Fourier transform/computer for processing radar data such as that from synthetic aperture radar. This FFT/computer should provide high speed, high volume operation while keeping the processor small and lightweight. The signal processor should handle 20 million operations per second (MOPS) for the FFT and 50 million operations per second for image matching with a memory of 10^7 bits.

AF87-006. TITLE: Recrystallization of Nitroguanidine

OBJECTIVE: To investigate methods of recrystallization of standard low bulk density nitroguanidine into large cubical or spherical shaped particles suitable for use in insensitive castable formulations.

DESCRIPTION: The Air Force is interested in developing an insensitive explosive to replace the current explosive used in MK 80 series general purpose bombs. Utilizing an explosive that is less sensitive to shock and thermal stimuli will increase operational readiness by allowing more munitions to be stored in existing facilities. Nitroguanidine holds great promise as an ingredient in insensitive explosive formulations. Formulations being investigated utilize high bulk density (greater than 0.9 grams/cc) nitroguanidine and other solid ingredients with a minimum amount of liquid binder to obtain a pourable mixture. Due to high solids content (84-86%), the relative sizes and shapes of the solid particles are critical in obtaining a pourable mixture. Current facilities produce high bulk density nitroguanidine crystals that are small (less than 100 micron) and needle-shaped. This type of nitroguanidine is unsuitable for use in high-solids insensitive formulations. Cubical or spherical nitroguanidine particles that have an average particle diameter of 400-600 microns are needed for use in insensitive castable formulations.

The program will concentrate on continuous methods that are feasible for scale-up to production requirements (about 10 million pounds per year).

AF87-007. TITLE: Correlation of Small Scale Tests for Explosive Sensitivity and Performance to the Full Scale Munition

OBJECTIVE: To develop better small scale correlation of explosive sensitivity and performance tests to eliminate costly large scale testing.

DESCRIPTION: The current process of developing a new explosive formulation involves many small scale screening tests which do not translate or correlate to the all up full scale munition. This could be due to mass, confinement and critical diameter. Improved methodology is needed in small scale testing to improve coorelation with large scale testing and screening capability.

AF87-008. TITLE: Concepts for Advanced Weapon Suspension Devices

OBJECTIVE: The objective of this program is to develop advanced weapon suspension devices that do not protrude into the airstream after the weapons have been released from the aircraft.

DESCRIPTION: Weapons are currently attached to aircraft with suspension devices. There are two general categories of these suspension devices, bomb lugs and missile hangers. Both are attached to and extend from the surface of the weapon and lock into the bomb rack or missile launcher to secure the weapon to the aircraft. When the weapon is released from the aircraft, the lugs and hangers remain with the weapon and protrude into the airstream. This adversely affects the performance and survivability of the weapon in free flight. For advanced standoff weapons and missiles, this degradation is unacceptable.

Contractor developed advanced weapon suspension devices should not protrude into the airstream after the weapons have been released from the aircraft and these devices should be compatible with or readily adaptable for use with existing bomb racks and missile launchers.

AF87-009. TITLE: Precision Tracking Platform for Portable Time, Space, Position Information (TSPI)

OBJECTIVE: To develop a highly portable radar tracker capability which utilizes Global Position System (GPS) capabilities, celestial navigation, or any other physical phenomena to make real-time platform data corrections.

DESCRIPTION: With the increased sophistication of guided weapon systems under development, requirements to track these weapons at lower altitudes and with better accuracies are exceeding the capabilities of our fixed based precision trackers. Most precision tracking systems are fixed based radar systems with coverage over specific ranges and above specified altitudes. A need exists to develop a technique by which a portable, medium precision tracking system can be used to provide high precision data in range and angles. With the ability to locate the radar system close to the coverage zone, the radar system will not require high transmitted power or contain a highly accurate angle tracking system. With current electronics and additional inputs such as Global Position System (GPS) and celestial navigation, a system could be designed to provide real-time correction to the tracking platform data for increased accuracy.

AF87-010. TITLE: Lightweight Composite Gun Barrels

OBJECTIVE: The objective of this program is to identify and analyze possible composite materials for application to aircraft gun barrels and to design, fabricate, and test a lightweight composite gun tube.

DESCRIPTION: Advancements in materials have extended their possible application to modern rapid fire aircraft guns. Of particular interest is the development of a lightweight composite gun barrel that will withstand the internal ballistic cycle of 20-30mm aircraft guns. Rapid fire weapons produce temperatures in the $1600^{\circ}F$-$1800^{\circ}F$ range and pressures up to 70,000 PSI during a single shot cycle less than 5 milliseconds in duration. Larger

bore, lower pressure rocket launchers and 105mm composite gun tubes have been developed and successfully produced. Smaller bore composite gun tubes have been demonstrated but not successfully produced. Smaller bore composite gun tubes have been demonstrated but not successfully tested at operational temperatures and pressures. Thirty millimeter gun tubes made by wrapping a steel liner with wire reinforced composite have been fabricated. The next step in advancing the state-of-the-art in aircraft gun tubes is an all composite, lightweight (i.e., approximately half of the current production weight) tube, capable of withstanding the operational environment.

AF87-011. TITLE: Portable High Explosive Pressure Transducer Calibration

OBJECTIVE: The objective of this program will be to investigate mechanical, hydraulic, or pneumatic devices capable of generating pressure pulses up to 200 psi with rise times of less than 25 microseconds, with an accuracy of one percent or less.

DESCRIPTION: The measurement of free air high explosive pressure waves is an important part of the development of new non-nuclear weaponry. The calibration of a high explosive pressure transducer is the key to accurate data and presently is a major weak link in the measurement of high explosive phenomena. The present calibration procedure is to use various means of quick opening valves, drop ball devices and vibration type calibrators. All of these lack portability for field use and are not fast enough to produce a simulated high explosive pressure pulse.

This program shall investigate mechanical, hydraulic, or pneumatic devices capable of generating pressure pulses up to 200 psi with rise times of less than 25 microseconds, with an accuracy of one percent or less. The pressure pulse generator must be portable, with a minimum of ancillary equipment and must be designed for a one or two-man operation.

AF87-012. TITLE: Development of Explosive Technology for Preferred Path of Detonability Warheads

OBJECTIVE: The objective of this effort is to determine the feasibility of and techniques for locally altering the sensitivity of the parent explosive of a warhead.

DESCRIPTION: Current and developmental non-unitary and directional warheads require complex and costly multipoint initiation systems such as explosive hydra networks to produce plane wave detonation fronts or to shape detonation waves for fragment and jet formation. These initiation systems typically require the inclusion of non-reactive inert materials and a variety of explosive types to accomplish the desired or preferred path of detonation through the warhead fill. By removing the need for non-reactive materials and simplifying the initiation system to a single point system these warheads could be made more efficient and less costly with identical effects on fuzing system cost and complexity.

This effort shall determine the feasibility of and techniques for locally altering the sensitivity of the parent explosive of a warhead, including Insensitive High Explosives (IHE), along specific paths from a single initiation point such that detonation fronts are propagated along these paths to the desired main fill detonation sites without initiating the main fill in the process. A direct analcg is the doping and alteration of the electrical characteristics of silicon substrates for integrated circuits. Alteration of the parent explosive by implanting analogs to those for integrated circuits (ICs) will be explored as well as more obvious mechanical techniques wherein the preferred paths are molded or machined into the parent explosive and then filled with a suitably modified form of the parent explosive.

AF87-013. TITLE: <u>New High Energy Storage Devices for In-Line and Electronic Fuzes</u>

OBJECTIVE: The objective of this effort is to identify and investigate non-capacitive technologies for storage of electrical energy in Air Force fuzes.

DESCRIPTION: Current inventory and developmental electronic fuzes use electrical energy from environmental devices such as ram air turbine generators. In some cases the electrical energy is provided to the fuze via an umbilical to the aircraft during the initial motion following release. In all cases the electrical energy must be stored after generation for use by logic circuits and safe, arm and fire mechanisms. Typically the energy is stored in a capacitor of some description or in an inductor then drawn off the fuze mechanism to operate its circuits. When the target is detected, energy is used to initiate the explosive train by setting off an electrical detonator. With the advent of more and more complex fuzes, which require the stored energy to last for long flight times or to survive severe impacts or to power high drain electronic devices, the demands placed on current capacitor technology have exceeded its capabilities. Generation of sufficient electrical energy for fuzing requirements is not a problem, but storing that energy at a sufficiently high density, in a small enough volume and with high enough efficiency of extraction is a notable problem. Efforts to advance the state-of-the-art for capacitive devices are already underway. The intent of this effort is to explore alternatives to capacitors for storage of electrical energy in fuzes.

This effort shall identify and investigate non-capacitive technologies for storage of electrical energy in Air Force fuzes. Critical factors are: 1) small size, 2) high energy density, 3) high (1500 volts) and low voltage capabilities, 4) impact survivability, 5) maximum discharge rates compatible with slapper detonator technology, 6) high energy capacity (several joules), and 7) low cost. Viable technologies shall be identified and the effort required to advance these technologies shall be assessed.

AF87-014. TITLE: <u>Low Cost Recyclable High Voltage Switch</u>

OBJECTIVE: The objective of this effort is to investigate recyclable low cost switching techniques.

DESCRIPTION: In-line fuze firing systems under development by the Air Force utilize a solid dielectric explosively activated switch as the primary candidate for slapper detonator triggering. This technology has been explored extensively and has proven advantages for many weapon applications. However, an alternative approach is desired especially for applications where high shock survivability is not required. The explosive switch is not recyclable, limiting the testability/reliability of the total fuzing system. It is highly desirable to eliminate such explosive components housed with testable components (electronics, etc.). The explosive switch is the only component that now prevents the development of a totally testable fuze electronic subsystem.

This effort shall investigate recyclable low cost switching techniques. The switch must have a short function delay (100 nanoseconds or less) for a 2000 volt firing system voltage. It is preferred that the switch be capable of manufacture using semiconductor micromachining technology.

AF87-015. TITLE: Conversion of Stored Chemical Energy to Electro-Magnetic Energy

OBJECTIVE: The objective of this program will be to investigate concepts of converting chemical energy into electromagnetic energy.

DESCRIPTION: Because of current trends of targets of interest, there is a need for unique and innovative methods of energy partitioning and enhancement of target coupling techniques. Maximizing the efficiency in the conversion of chemical energy into various forms of electromagnetic energy is of interest.

AF87-016. TITLE: Non-accelerometer Techniques for Determining Rigid Body Motion of Penetrating Weapons in High Shock Environments

OBJECTIVE: The objective of this effort is to develop and evaluate at least one new device for measuring the rigid body motion of penetrating weapons in real time.

DESCRIPTION: Current Air Force development efforts for "smart" fuzes for penetrating weapons rely upon electronic accelerometers using piezo effects to gather real-time data on the rigid body motion of penetrating weapons for burst point control. These accelerometers, be they normal instrument type or solid state, have operating features which severely complicate the processing of data by fuze logic to determine distance, velocity and acceleration changes in the weapon caused by target features. Severe difficulties arise when trying to discriminate between the actual low frequency rigid body accelerations which are reflective of projectile motion within the target and the higher frequency body responses indicative of body ringing caused by short shock pulses of high amplitude. Added to this problem is the difficulty in identifying and rejecting or accounting for apparent motion data caused by the elastic/plastic responses of the penetrator such as bending and the off-axis components of motion resulting

from unpredicted angles of attack, etc. A new device capable of providing real-time motion data to a "smart" fuze under conditions of high shock is needed.

This effort shall find or develop and evaluate at least one new device for measuring the rigid body motion of penetrating weapons in real time. Potential viable technologies will be identified and the effort required to advance them to practice will be determined.

AF87-017. TITLE: Advanced Radiographic Techniques and Applications

OBJECTIVE: This effort is to advance the utility of radiography as an analytical tool.

DESCRIPTION: This requirement is for advances in the area of radiographic instrumentation for diagnosis of high explosive dynamics and terminal effects of high velocity projectiles. Specific topics of interest include multiple pulsed flash x-ray sources; large format, high resolution x-ray imaging detectors; high resolution, small aperture sources; multispectral radiographic sources; and tomographic signal processing for flash radiography. Also of interest is radiographic electronic data reduction for density, volumetric measurement, velocity, fragment size, frame-to-frame correlation and other image reduction techniques.

This effort is to improve the productivity of advanced development and test programs, to provide time resolved multiple exposure images of terminal/in bore hypervelocity projectiles, automate and standardize reduction of radiographic imagery and to advance the utility of radiography as an analytical tool.

AF87-018. TITLE: Feasibility Study of Pre-Impact Target Mapping for Air Force Penetrating Weapons

OBJECTIVE: The objective of this effort is to study the feasibility of providing the current and planned Air Force hard target weapons with a pre-impact target mapping capability.

DESCRIPTION: Current Air Force weapon development programs include the development of penetrating weapons capable of defeating hardened underground structures and facilities. The capability of physically penetrating a given target has been achieved as well as a degree of post impact burst point control by monitoring the rigid body motion of the penetrator in real time. In spite of these achievements the effectiveness of the weapons is limited by the degree to which the impact parameters can be controlled and the extent of pre-encounter target knowledge. The effect of target variability on weapon effectiveness is substantial in that the post impact path of the weapon can become unpredictable (making current burst point control mechanisms useless), and the placement of critical components within a complex target is easily varied. A method for determining the position and structural detail of the target immediately prior to impact is required.

Given this real-time intelligence the existing burst-point control mechanisms can be enhanced to provide an optimized burst point irrespective of target variability.

This effort shall carry out a study wherein the feasibility of providing the current and planned Air Force hard target weapons with a pre-impact target mapping capability is determined. Millimeter wave technology holds some promise of providing this capability but may not be the only avenue to pursue. This effort will determine the feasibility of pre-impact target mapping and identify the technologies requiring further development to achieve this goal.

AF87-019. TITLE: Application of Artificial Intelligence to Target Vulnerability Assessments

OBJECTIVE: The objective of this effort is to develop Artificial Intelligence techniques for target vulnerability assessment methodologies.

DESCRIPTION: The assessment of the vulnerability of targets to conventional weapon kill mechanisms has evolved over thee years to an empirical science. Major methodology development efforts have been directed toward developing analytical tools and techniques for predicting the target component damage resulting from the kill mechanism/target component interaction. These efforts have resulted in several models, one of which is the Pointburst Damage Assessment Method (PDAM), used largely in the vulnerability assessment of armor targets. These analytical models and algorithms, used to estimate vulnerability, rely on an experimental data base to make realistic estimates of actual damage achieved. Frequently, there is a data base deficiency from which to make vulnerability assessments; thus the vulnerability analyst is asked to use expert opinion in employing the methods of assessments. Artificial Intelligence (AI) advancements have resulted in capabilities to substantiate machine intelligence for human decision making. There appear to be applications of AI to vulnerability methodology that may improve assessments.

This effort shall develop Artificial Intelligence techniques for target vulnerability assessment methodologies. Specific comparisons of these new techniques to existing methods are required. As the results of this effort will be used by vulnerability analysts, emphasis must be placed on clear communications. Reliance on Artificial Intelligence jargon should be minimized.

AF87-020. TITLE: Variable Configuration E/O Simulator Development

OBJECTIVE: This effort would define concepts and fabricate prototypes of modular simulators which could be used for the performance testing of optical threats in the 532 Nanometer to 14 micrometer region.

DESCRIPTION: Research and development is required for variable cross section electro-optical simulators to provide an analytical resource for the testing of various electro-optical threat/countermeasures systems. This effort would

define concepts and fabricate prototypes of modular simulators which could be used for the performance testing of optical threats in the 532 Nanometer to 14 micrometer region. Parameters to be simulated include entrance aperture, number of reflecting or transmissive components, exit pupil, focal length and number of focal planes. Parameters to be measured include spectral power density, pulse duration, interpulse period, wavefront distortion and percentage of time on target. The simulator will also be utilized to present a typical threat system cross section to a countermeasure system under test.

This effort will also define operational techniques for effective use of the simulator including remote operation, and pointing at and tracking of the threat source.

AF87-021. TITLE: Cryogenic Radiation Monitoring Microscope

OBJECTIVE: Develop a cryogenic radiation monitoring microscope as a diagnostic instrument to evaluate cryogenic arrays when they are produced.

DESCRIPTION: The demand for a cold background, IR scene generator has led to several developmental programs to produce cryogenic arrays which have elements which can be selectively heated. A cryogenic radiation monitoring microscope is needed as a diagnostic instrument to evaluate these arrays when they are produced. The microscope would have to operate at cryogenic temperatures and under vacuum conditions in order to reduce its own radiation loads. It would require all reflective optics to cover the wavelength range from 1-25 micrometer and would need a mechanism to remotely select bandpass filters. The system would have a scanning capability over the surface in 0.1 mil steps.

The detector in the instrument should have sufficient sensitivity throughout the wavelengths of interest to detect features ranging in temperature from $1500^{o}K$ to $20^{o}K$.

AF87-022. TITLE: Dynamic Pressure Response Calibrator

OBJECTIVE: Develop an improved dynamic pressure calibrator.

DESCRIPTION: Dynamic pressure measurements, made in support of turbine engine and rocket propulsion testing, require use of complex transducer/tubing configurations. Analytical estimates of system frequency response need to be verified experimentally. Current devices for determining the frequency response characteristics are often limited in amplitude range, bandwidth, etc. An improved dynamic pressure calibrator is needed. The operating frequency range should be 2 to 500 Hz with the output amplitude flat within $\pm$ 0.5 dB over this range. Absolute amplitude accuracy is of secondary importance but should be within $\pm$ 1dB. The output level should be selectable from 1×10^{-3} to 1 psi rms. The output waveform options to include sinewave and random is highly desirable. External volumes up to 10 in^3 and tubing diameters up to 1/4" ID must be accommodated. Means for measuring the generated pressure levels and signal phase during operations must be included.

AF87-023. TITLE: Real-Time Flow Vector Measurement

OBJECTIVE: Develop instrumentation to measure and display in near-real-time the local three-dimensional airflow velocity vectors at a plane approximately 6 to 36 inches upstream of full-scale aircraft propulsion system inlets.

DESCRIPTION: The output signals must be usable as inputs to a closed-loop automatic control system for the vector magnitude and direction. A primary requirement is that the sensor(s) produce minimal disturbance or interference to the flow field entering the inlet. Small sensors (1-in maximum dimension) or non-intrusive (remote) sensors are required. Instruments currently used for similar measurements include combination total-and-static pressure probes for air speed and cone or hemisphere probes for flow angles. A "flying cruciform" with an integral force balance has been used based on the lift coefficients generated by the cruciform elements as functions of angle and Mach number. The instruments should operate over the Mach number range of 0.3 to 0.9, at static pressure of 0.5 to 14.7 psia, and total temperatures of -120 to 200 deg F. Flow angle range is from 60 deg below horizontal to 20 deg above horizontal in the vertical plane and ± 15 about the axial direction in the horizontal plane. Frequency response must be sufficient to display vectors at rates of change of Mach number up to ± 0.1 per sec, and flow angles changing at 0 to 10 deg/sec. Required accuracies are ± 0.02 Mach number and ± 1.0 deg during transient operation. Continuous operation up to 12 hours without servicing is required.

AF87-024. TITLE: Composite Material Tester

OBJECTIVE: Develop a concept for a composite materials tester.

DESCRIPTION: Composite materials (mainly graphitic) are tested in the Aeroballistic Ranges at the Arnold Engineering Development Center. To design successfully the models used, the strength properties of these materials should be known, preferably under dynamic conditions. A concept for a composite materials tester is needed, leading to the building of such a device for use at AEDC.

It should have the following capabilities:

- (a) Determine ultimate tensile strengths in each of three orthogonal axes.
- (b) The corresponding stress-strain curves.
- (c) Perform tests at strain rates up to 104 in./in./min.
- (d) Perform similar range of test for cross axis shear strengths.
- (e) Require use of minimum material to obtain strengths.
- (f) Not introduce off axis loads during testing.

The materials to be tested are in short supply, variable in properties, have low strains to failure and are not isotropic.

AF87-025. TITLE: Ballistic Range/Track Alignment Diagnostics

OBJECTIVE: Develop an expedient and inexpensive technique to conveniently check the alignment of the track assembly which includes a 1000-ft-long guidance track (four surrounding guide rails), and a 500-ft-long recovery tube housed in the AEDC Hypervelocity Range/Track G Facility.

DESCRIPTION: Preliminary engineering analysis indicates the feasibility of using a reusable telemetry/on-board recording package containing accelerometers and/or displacement sensors and an appropriate rechargeable power source to satisfy this requirement. The sensor package must fit within an AEDC-supplied projectile. This will require the dimension of the sensor package to be no more than 2 inches in diameter and less than 18 inches in length. Design of the projectile and encapsulation of the package into the projectile will be done by AEDC. This diagnostics package must be capable of withstanding launch accelerations of 10,000 g's axially and 5000 g's radially. Recording/transmission of information must begin upon launch and must continue for at least 2 seconds. A data sample rate of approximately 10 kHz is required.

AF87-026. TITLE: Pulse to Digital Conversion System

OBJECTIVE: Develop an instrument which provides a one-step conversion process directly from pulse rate to digital.

DESCRIPTION: Turbine flowmeters and tachmeters are commonly used for measurement of fluid flows and rotor speeds during engine and rocket propulsion testing. These devices produce pulse outputs proportional to flowrate or speed. Typically, two signal conversions (pulse to analog then analog to digital) are required prior to recording the outputs on digital recorders. The converisons to and from analog are undesirable and introduce additional measurement errors. An instrument is needed which provides a one-step conversion process directly from pulse rate to digital. The pulse rates vary from 2 to 5000 Hz with each channel required to operate over 200 to 1 range. The recorder data acquisition rate will be from 1 to 200 readings/second (16 bit words). The system should not require control signals from the data recorder other than simple read commands. The frequency response should be 10 Hz or greater, with accuracy and resolution at all pulse and data acquisition rates .01 percent or better. System packaging should permit use of up to 30 data channels simultaneously. The wide frequency operating range and data acquisition rates preclude the use of simple digital pulse rate or period measuring counters.

AF87-027. TITLE: Protective Duct Coating

OBJECTIVE: Develop a coating for ferrous metal which can be subjected to temperature extremes from 120^{o}F To 600^{o}F in a moisture-laden atmosphere.

DESCRIPTION: AEDC experiences many problems related to rust and other foreign debris being ingested by test engines or impacting test models. The predominate source of this problem is ferrous metal ducting interior surfaces which are constantly subjected to high air mass flows at extreme

temperature ranges. Various coatings have been applied to the surfaces in the past with limited success. A coating which can be subjected to temperature extremes from 120°F to 600°F in a moisture laden atmosphere is required. In-house studies and conversations with coating manufacturers have indicated that a coating which will meet all the criteria is not presently available.

AF87-028. TITLE: Quality Assurance of Surface Mounted Printed Circuit Board Assembly Solder Joints.

OBJECTIVE: To develop methods for an overall solder joint quality assurance system.

DESCRIPTION: Surface mounted components have many advantages in production and design (higher component density, lower assembly costs, improved production control) for military electronics. Within five years, surface mounted designs are expected to surpass conventional through-hole designs in volume. The main drawback of surface mounted PCB assembly is difficulty inspecting solder joints, especially those covered by leadless components. Some new techniques for surface joint inspection have become available recently using X-rays and pulsed lasers. Pure inspection techniques, however, provide only after-the-fact data on solder joint quality. For this program, innovative methods for an overall solder joint quality assurance system are desired. Integrated concepts combining exact control of solder processes with automatic inspection techniques will be developed and demonstrated.

AF87-029. TITLE: Electronic Equipment Shelters

OBJECTIVE: Develop design concepts for electronic equipment shelters using advanced materials.

DESCRIPTION: Present shelters for electronic equipment are built using foam-and-beam panels with metal skins, or aluminum or paper honey comb materials. Materials limit configuration choices because of size and weight limitations vehicles which transport them. Delamination of materials remains a problem. Develop design concepts for electronic equipment shelters. Investigate possible advantages of developing or using metal-composite or composite materials for shelters. Use non-isotropic strength properties to suit the stress distribution in composite materials. Conductivity and bonding requirements must be addressed. Provide a detailed evaluation of using new composite and fiber reinforcement materials.

AF87-030. TITLE: Phased Array Antenna Elements

OBJECTIVE: Develop a wideband phased array antenna element for use on airborne surveillance platforms.

DESCRIPTION: Develop a wideband phased array antenna element for use on airborne surveillance platforms. The element must be small, lightweight, efficient, and easily producible. The radar will be a dual frequency surveillance/tracking system optimized for the detection of low radar cross

section targets. Array elements should be sized for an UHF to L band surveillance frequency and a L band or higher tracking frequency. Possible applications include either conformal or planar phased arrays. Effort should include design, fabrication, and test of a single element, and a brief study of the element's producibility and it's utility for use in an airborne phased array.

AF87-031. TITLE: Reduced Cost Transmit/Receive Modules

OBJECTIVE: Develop methods to lower the cost of packaging single chip and multiple chip microwave monolithic integrated circuits (MMIC) transmit/receive modules.

DESCRIPTION: Transmit/receive modules are a major cost in building phased array radar surveillance systems. Any significant reduction in the cost of these modules will result in a dramatic reduction in system cost. The primary area of interest is for UHF or L band modules to be used in future airborne surveillance systems. Task objective is development of innovative methods to lower the cost of packaging single chip and multiple chip microwave monolithic integrated circuits (MMIC) transmit/receive modules. Any study should include a study of the impacts on reliability, maintainability, and life cycle cost. The impact on size, weight, and power dissipation should be addressed. The task may be completely conceptual in nature, or may include the development of detailed plans or hardware.

AF87-032. TITLE: Automated Air Traffic Control System Concepts

OBJECTIVE: Develop new concepts for safe movement of aircraft using passive identification methods and data link interchanges.

DESCRIPTION: Future Air Traffic Control (ATC) systems will need new concepts for the safe movement of aircraft. Systems using passive identification methods and data link interchanges are possibilities. Current systems use high powered emitters (e.g. radar) for identification and active UHF/VHF radio for communication requirements. Additionally, navigation equipment does not afford a common grid reference nor does it lend itself to long range relative accuracy. The future system must allow for information distribution and processing flexibility and be precise enough for safe ATC operations. Potentially applicable technologies for possible interface and/or merger would be the Inertial Navigation Systems, NAVSTAR GPS, Joint Tactical Information Distribution System (JTIDS), and other related ongoing programs.

AF87-033. TITLE: Airspace Management

OBJECTIVE: To develop a roadmap for dealing with and incorporating a military air traffic control management system in conjunction with the FAA.

DESCRIPTION: The Federal Aviation Administration (FAA) has outlined their National Airspace Systems (NAS) Plan which previews how they will perform air traffic control (ATC) in the future. The Air Force has an interest in this

FAA system upgrade due to the potential effect it will have on the military mission requirements. There are a number of issues within the NAS Plan that may positively or adversely affect military ATC and flying mission responsibilities. There is a need to identify key issues in the NAS Plan as they relate to current and future military requirements. There is also a need to develop a potential roadmap for dealing with and incorporating a military management system in conjunction with the FAA.

AF87-034. TITLE: Meteor Burst Communications (MBC) Throughput Improvement

OBJECTIVE: Provide a user handbook or computer models which can relate MBC system parameters to guide optimal siting and operation of MBC systems for reliable throughput.

DESCRIPTION: Military and non-military use of meteor burst communications (MBC) has increased recently. MBC systems operate in the 40 MHz frequency range and use take-off signal elevation angles between 5 and 30 degrees depending on the transmitter/receiver geometries. The received signal is perturbed by the nature of the path which includes irregular terrain, vegetation, ground installations and tropospheric ducting. Ways are needed to achieve a reliable system throughput through: modelling of transmission path effects on received signal perturbation; use of adaptable antenna patterns to exploit atmospheric ducting; or other methods. Provide a user handbook or computer models which can relate MBC system parameters to guide optimal siting and operation of MBC systems for reliable throughput.

AF87-035. TITLE: Discrimination of Arctic Radar Clutter Returns

OBJECTIVE: Devise radar signal processing algorithms to compensate for arctic radar clutter effects.

DESCRIPTION: SEEK IGLOO and North Star warning radars have observed strong radar clutter returns. Investigate the origin of the clutter returns to provide ways to discriminate the source, i.e. packed ice blocks, bird migration, atmospheric anomalies, etc. Estimate the relative effect of these types of clutter on warning radar operations. Devise radar signal processing algorithms to compensate for these clutter effects.

AF87-036. TITLE: Command, Control, and Communications Systems/Subsystems

OBJECTIVE: To develop new concepts and innovations for Command, Control, and Communications Systems/Subsystems.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of Command, Control and Communications (C3) System and Subsystem research, development and procurement. The innovator is given latitude to include areas not specifically addressed by other specific C3 topics. This general area covers the full spectrum of AF C3 Missions including: Strategic C3; General Purpose Forces C3; Ballistic Missile Tactical Warning/Attack Assessment; Atmospheric Surveillance and Warning: World Wide C2; Air Traffic

Control; and all communications technologies. Emphasis is placed on potential long term planning concepts. Topics as diverse as weapons and improved operating concepts techniques, and technologies may be submitted. Some other areas of interest include: advanced communications networks, data base management systems, information processing technologies, multilevel secure communications, onboard satellite data processing systems, advanced HF/VHF/UHF/SHF/EHF communications systems, applications of artificial intelligence, innovative RD organizational concepts, air surveillance systems concepts and technologies, signal processing, etc. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF87-037. TITLE: Simulation of Bistatic Target Detection in Clutter

OBJECTIVE: To develop computer software to simulate a bistatic radar system.

DESCRIPTION: The use of bistatic radar systems to detect targets against high clutter background has had little study. There is a paucity of information on which to construct such systems. The present effort would entail the development of computer software to simulate a bistatic radar system. For reference, a similar monostatic simulation was reported in RADC-TR-86-3. The simulation would include waveform generation, transmission, reflection of the radar signal from targets and discrete and distributed clutter, bistatic reception, processing of the received signal, and detection of any targets. The transmitter is airborne and the passive receiver is either airborne or ground-based. The clutter may consist of rain, chaff and/or ground reflections; its amplitude statistics may be Rayleigh, log-normal or Weibull distributed. The radar simulation should include flexible location schemes for a number of targets at arbitrary positions. The output would be the probabilities of detection of each target, for constant false alarm rates (CFAR processing). The initial phase would develop the simulation flowchart and the analytical formalism of the individual component subroutines (clutter, CFAR, signal transmission, etc.). A follow-on effort would implement the programming, validate the system, and generate representative cases.

AF87-038. TITLE: Time-Domain Measurements in the Near Field

OBJECTIVE: To perform a research program to investigate theory, experimental techniques, and computations in the area of near-field measurements in the time domain.

DESCRIPTION: The measurement of the complete bistatic radar cross section (RCS) of a general scatterer over a broad frequency range is so time consuming on conventional radar measurement ranges that broadband, bistatic data is virtually non-existent. However, near-field cw measurements have been developed in recent years that supply complete, complex radiation patterns with a single scan of the antenna or scatterer. Moreover, it is conceivable that baseband time-domain measurements could also be done in the near-field at relatively low power. Such near-field time domain measurements would enable (with a single scan) the determination of bistatic radar cross section over a wide frequency band. We, therefore, recommend an

innovative research program to investigate theory, experimental techniques, and computations in the area of near-field measurements in the time domain. As a prerequisite to RCS near-field measurements in the time domain, the technique would first be developed and applied to pulsed antennas. Specifically, the contractor would be expected to extend to the time domain the existing near-field formulation for measuring antennas at a single frequency. The time-dependent far-field of a pulsed test antenna would then be determined from time-domain measurements taken in the near-field of the antenna. By means of the near field time-domain formulation, cw far-field patterns of the test antenna would be computed over an appreciable bandwidth of frequencies. The computed cw far-field patterns would be compared with the corresponding far-field patterns obtained from conventional cw measurements at a few test frequencies. Finally, the technique would be applied to simple scatterers illuminated by a pulsed electromagnetic wave.

AF87-039. TITLE: Reduction of Scattering from Reflector Antennas With Tapered Feed Illuminations

OBJECTIVE: To develop reliable, low-cost, easy-to-implement techniques for reducing unwanted radiation-mode scattering to levels that will allow their use on low cross section platforms.

DESCRIPTION: The radiation mode scattering from uniformly illuminated reflector antennas can be eliminated by terminating the feed with a conjugately matched load. However, for reflector antennas with tapered feed illuminations the radiation mode scasttering remains high even under ideal load conditions. Moreover this strong radar return is not being addressed by present efforts to reduce antenna radar cross section. Reliable, low-cost, easy-to-implement techniques, suitable for retrofitting existing antennas, are needed for reducing this unwanted radiation-mode scattering to levels that will allow their use on low cross section platforms.

AF87-040. TITLE: Demonstration of a Dispersed, Highly Thinned, Phased Array Radar

OBJECTIVE: To design an experiment that can be used as a proof-of-concept for dispersed, highly thinned Phased Array Radar.

DESCRIPTION: Airborne and space-based microwave sensors of the future could be dispersed and highly thinned for a variety of reasons - to maximize the use of all available surfaces on an aircraft and to increase survivability. The economics of deploying such sensors strongly suggest the use of a controlled ground based experiment in order to demonstrate the underlying principles behind a dispersed, highly thinned phased array. Thus, the object of Phase I of this effort will be to design an experiment that can be used as a proof-of-concept. The design shall be to the subsystem level and give evidence of addressing the following technical issues surrounding a system with the following characteristics: (a) self-organizing, (b) reconfigurable, (c) self cohering on clutter or signals of opportunity, (d) self registration, (e) beamforming on transmit and receive, (f) communication among sub-elements of the dispersed system, (g) self surveying, (h) self diagnosing and healing.

AF87-041. TITLE: Near-Field Scanning

OBJECTIVE: To establish the validity of near-field scanning on an external sphere as a practical and economical technique for measuring very large antennas, and prepare a preliminary functional design for such a range that would be suitable for measuring large antennas.

DESCRIPTION: Development of the concept requires several investigations. First, the theory of scanning on an external sphere must be rigorously formulated. Then suitable sampling intervals and efficient far-field computation methods must be determined. The supporting measurement system must be designed to match the special requirements of the method. The effects of dynamic range, bandwidth, phase and amplitude measurement errors, probe position error, must be establishd. Finally, a simple laboratory experiment that demonstrates key issues should be designed and carried out to test the method. Some task examples are: Develop expressions for the mechanical motion of the probe (Foucault Pendulum); develop data sampling roles and computer computation methods for accurate and efficient determination of antenna far fields from measured near-field data, prepare a preliminary functional design for a near-field range that could accommodate X-band antennas up to 20 meters in diameter.

AF87-042. TITLE: Dynamic Matching Techniques for Monolithic Microwave Integrated Circuit (MMIC) Modules

OBJECTIVE: To develop a replacement for the circulator between the transmit/receive module and the radiating element in microwave radars.

DESCRIPTION: Monolithic Microwave Integrated Circuit (MMIC) modules are currently under development for active aperture phased array surveillance radar antenna systems. The motivation is to reduce the size, complexity, and cost of phased arrays for space, airborne, and ground applications. A large change in element input impedance occurs when the array is scanned. To isolate the module from this change, a ferrite circulator is inserted between the module and the antenna element. The insertion of the circulator is in direct conflict with the concept of MMIC technology and increases the module cost because it requires the introduction of circuit elements as a separate step in the production process. Therefore, research is desired to investigate techniques that: a) compensate for the scan-dependent impedance by introducing stub tuners, b) diode controlled shorting pins in the element, or c) additional transmission lines from the element to ground. The technique will focus on printed circuit arrays and circuit elements that already exist or are compatible with MMIC technology.

AF87-043. TITLE: High Dynamic Range External Modulator

OBJECTIVE: To develop a narrow line width stabilized laser with a high electronic dynamic range external modulator operating at 1.3 micrometers with a single mode optical fiber, optical detector and high dynamic range/electronic output.

DESCRIPTION: Electronic based systems will evolve toward hybrid electro-optic or all optical systems. Introduction of optical fiber to replace copper cable has been well established. There is also strong potential for single mode optical fiber to replace conventional waveguide. Advantages are obvious: large bandwidth, low dispersion, small size/weight, low attenuation; however, replacement with single mode optical fiber involves replacing a passive waveguide with an active optical system. Thus parameters not heretofore addressed must be considered, e.g. phase noise, non linearity, dynamic range. These parameters must be well controlled to assure "transparency" to the signal. It is necessary to develop high dynamic range lasers or external modulators to achieve this end. The design would be a narrow line width stabilized laser with a high electronic dynamic range external modulator operating at 1.3 micrometers with a single mode optical fiber, optical detector and high dynamic range/electronic output. The objective is to achieve 120 dB of electronic dynamic range from 1 microvolt to 1 volt with nonlinear distortions better than 60 dB and operating at radio frequency inputs up to 60 GHz.

AF87-044. TITLE: Wideband Active Array Control Components

OBJECTIVE: To develop low cost hardware integration of the active electronic functions required at the subarray and concepts for low-cost phase shifters and time-delay steering of phased arrays up to 60 GHz.

DESCRIPTION: Large distributed array antennas for Electronics Surveillance Measures (ESM), surveillance and communications will require intelligent active electronics at the subarray or element level. Coherence, timing, control and information signals will be distributed to the subarray electronics by lightweight, wideband optical or millimeter wave communication operating through space or fibers. Novel approaches are required for the low cost hardware integration of the active electronic functions required at the subarray. These functions are: multi-plexing/demultiplexing information on the communications links, integrated sensors to determine subarray position, orientation and electronic functioning signal generation, control (phase shifting, time delay), isolation, radiation and processing and electronically controlled reconfiguration of subarray electronics to survive failure or damage.

Novel ideas are sought for low-cost phase shifters and for time-delay steering of phased arrays up to 60 GHz. Total time delays and increments should be appropriate for phased arrays up to 20 meters. Integration of analog and digital control components on a single chip is desired. Similarly, the integration of optical and microwave devices. The long term goal is to integrate digital, microwave (including non-reciprocal) devices, and optical devices on a single, low-cost wafer.

AF87-045. TITLE: Structural Multifunction Phased Array Antennas

OBJECTIVE: To develop new concepts for reconfigurable, structural array antennas operating in the microwave and millimeter wave bands.

DESCRIPTION: Multifunction array antennas will be necessary for future airborne C3I surveillance, ESM and communications relay systems. To increase endurance, reduce platform radar cross section and increase payload volume, the array antennas will be incorporated into the load bearing skin of the aircraft. New concepts for reconfigurable, structural array antennas opera-ing in the microwave and millimeter wave bands are required. Methods to permit designers to effectively integrate array elements or subarrays which cover the whole band to achieve all aspect coverage are required. Alternately, the ability to rapidly reconfigure radiating elements to achieve specific radar, ESM or communications missions is of value. Array architectures and control philosophies must be considered also. To minimize bulky, multi-band corporate feeds, attention should be given to the use of large bandwidth busses to distribute coherence, timing, control, and information signals to distributed digital and control processors at the element or subarray levels. These distributed processors must effectively integrate local element/subarray performance monitoring and position information with global function, pointing and adaptive cancellation requirements to control the active electronics of the element/subarray. Adjunct technologies to effectively integrate the design and fabrication of active structural arrays with radomes for environmental and RCS control are desired. Innovative approaches are invited to solving any portion of the above problems.

AF87-046. TITLE: Optical-To-Microwave Laser Diode Source

OBJECTIVE: To develop new optical sources to enhance the performance of microwave electronic systems.

DESCRIPTION: New optical sources shall generate stable, narrowband microwave signals in the 5 GHz to 30 GHz range by photodetection of a pulsating optical beam from a miniature semiconductor laser diode, with no microwave oscillator present to modulate the laser emission. The laser diode shall include a saturable absorber and an external cavity whose length determines the microwave frequency. The wavelength of laser emission shall be in the 0.8 to 1.6 micron range, and the direct photodetection of the pulsating beam should produce a cw electronic signal with a strong fundamental component at the desired microwave frequency. A feasibility demonstration of this laser device is required. The offerer should have in-house facilities for constructing appropriate laser diodes.

AF87-047. TITLE: Optical Switching Using Nonlinear Optical Properties of Polymeric Organic Materials

OBJECTIVE: To fabricate optical quality thin-film and channel waveguides and to extend this technology to the development of waveguide modulation and switching devices.

DESCRIPTION: Optical switching is a prime requirement for future Air Force applications in communications and optical computing. Prior work in this area has relied on inorganic electro-optic materials like lithium niobate and lithium tantalate which, however, suffer from fundamental limitations. A large and expanding range of organic materials offers the possibility of performing

various optical functions including frequency doubling and switching. The immediate challenge lies in the optical waveguide and device fabrication techniques required to translate promising materials into working devices. Accordingly, this program will address the problem of fabricating optical quality thin-film and channel waveguides and the extension of this technology to the development of waveguide modulation and switching devices. The approach will utilize the linear (Pockels) electro-optic effect and hence will involve compounds exhibiting high second order nonlinear susceptibilities (Chi-squared) and noncentrosymmetric crystalline states. Both single mode and multimode type devices are of interest. The offeror will be expected to demonstrate waveguiding structures and experimental switching devices.

AF87-048. TITLE: Super-Refractory Compounds

OBJECTIVE: To develop processes for the controlled deposition of alternating layers of refractory compounds, where each layer's thickness is less than 10 nanometer (nm) and the total number of layers exceeds 30,000.

DESCRIPTION: Ultra Structures of refractory metals and their carbides, nitrides and borides is a promissing materials technology for creating unique electonic and structural parts. For example, it may be possible to incorporate electonic antennas and sensors into an aircraft skin using ultra structures of semi-conduction refractory compounds. The goal of this research is to develop processes for the controlled deposition of alternating layers of refractory compouunds, where each layer's thickness is less than 10 nm and the total number of layers exceeds 30,000. The process must be automated with growth rates of 25 microns/hr. The technique must include mechanisms for controlling purity and grain size within each layer. This is not a project devoted to advancing coating technology, but seeks to exploit the bulk mechanical properties of a macroscopic array of layers with quantum well thicknesses.

AF87-049. TITLE: Sentient Radio Receiver

OBJECTIVE: To design a sentient radio receiver using existing and new artificial intelligence technologies.

DESCRIPTION: A sentient radio receiver is one that applies advanced information theory and artificial intelligence to the detection and demodulation of received communications signals. The radio signals is most communications channels is distorted and/or perturbed by the propagation media and the addition of manmade or natural radio noise. The sentient receiver would be able to measure and build up a knowledge of recent past disturbances in the communications channel, and apply this knowledge along with historical and predicted statistics on the data/information flow over the radio system to extract the communications from the noisy received signal. The sentient receiver would thus be able to apply artificial intelligence technology to anticipate information that was transmitted, develop and acute awareness of propagation media and/or manmade distortions to the signal, and make expert judgement in correcting errors in the demodulated information to provide the best performance possible in high data transmission rates, anti-jam capability, and low probability of intercept within the communications system.

AF87-050. TITLE: Software for Non-Von Neumann Architectures

OBJECTIVE: To analyze non-von Neumann class architectures and determine how they can be utilized over weapon system and software life cycles.

DESCRIPTION: To date, software engineering technology has focused on the use of so-called conventional high order languages and computer architectures. Since the von Neumann architecture is characterized by serial processing techniques, it is very successful when performing complex computations on relatively small amounts of data. However, for certain classes of problems where relatively simple computations are to be performed concurrently on large amounts of data, the von Neumann type architecture is severely limited by the data transfer capability between the memory and processor components. The objective of this SBIR program is to analyze non-von Neumann class architectures and determine how they can be utilized over the system and software life cycle. Emphasis is to be placed on the assessment and determination of software tools and techniques that are applicable to these architectures, to determine if new approaches to the life cycle are required, and to best match software engineering technology to these architectures when the problem domain calls for a mix of sequential and concurrent processing.

AF87-051. TITLE: High Productivity Software Engineering Workstation

OBJECTIVE: To develop a design and implementation concept of a high productivity software engineering workstation to provide methodology enforcement and incremental analysis and feedback.

DESCRIPTION: The ever increasing cost and complexity of DoD software systems coupled with a labor intensive software life cycle process require the identification, development, and application of software engineering technology which provides significantly improved productivity and product quality. In particular, early life cycle activities associated with the requirements definition, specification, and validation processes may result increased software costs when accomplished in the present and relatively inefficient manner. Furthermore, current technology in this area requires the use of well trained and experienced people to be effective. This effort is intended to provide improvements by developing a design and implementation concept (with possible demonstration) of a high productivity software engineering workstation to provide methodology enforcement and incremental analysis and feedback. The techniques embodied in the workstation should support military standards and practices, rapid prototyping and high level requirements and design modeling. The design concept should address an open and extensible environment that will facilitate the subsequent incorporation of artificial intelligence and knowledge-based techniques as they evolve and mature.

AF87-052. TITLE: Expert System Integrated With Data Bases

OBJECTIVE: To demonstrate the ability of an expert system to use the currently maintained conventional orders-of-battle files, installation files or terrain tables without manually intensive efforts.

DESCRIPTION: Many potential applications for expert systems are precluded by limitations in ability of conventional expert system technology to function in conjunction with data systems. Rudimentary expert systems which are conventional data based management system (DBMS) have become commercially available in the last year. Expert systems integrated with DBMS would be of value to perform many functions in the Command, Control, Communications, Intelligence (C3I) domain. A reasonable demonstration of this capability would be the ability of an expert system to use the currently maintained conventional orders-of-battle files, installation files or terrain tables without manually intensive effort. A more valuable demonstration would be the ability to interface the Military Integrated Intelligence Data System (MIIDS) to an expert system without requiring manual intervention. This topic supports development of C3I Expert Systems containing integral DBMS.

AF87-053. TITLE: Profile Compiler

OBJECTIVE: To develop a faster method to recompile the profile library.

DESCRIPTION: Profiles are information retrieval queries using Boolean Logic to disseminate information relevant to a user's needs. A set of these queries is compiled to establish a profile library. Intelligence analysts rely on this profile library to retrieve message traffic for their review as it enters his analyst support system. Since user areas of interest are continually changing in the intelligence community, it is necessary to redefine portions of the profile library to accurately disseminate messages with the new required information. When profiles are changed, the set of queries must be recompiled to establish a new profile library. In many cases these libraries are very large and require as much as four hours of computer processing time to be recompiled. This processing time is on the host computer and must be accomplished during slack periods. A faster method is needed to recompile the profile library. In addition, the profile compiler should be capable of verifying the syntactic structure of the new set of profiles to avoid an abort of the compilation process due to errors.

AF87-054. TITLE: Advanced Crucible Technology

OBJECTIVE: To develop processes for the deposition of thin films of refractory compounds.

DESCRIPTION: The inability to control unwanted impurity incorporation during all phases of electronic device fabrication establishes a fundamental limit to device reliability and efficiency. Solving the containment contamination problem is essential to the production of superior opto-electronic devices.

All phases of electronic device production require crucibles and susceptors of the highest possible purity. Furthermore, these furnace elements must remain chemically inert with respect to all atomic and molecular species in a given reaction at elevated temperatures. Recent experiments with chemical vapor deposition indicate that ultra high purity layers of refractory compounds can

be deposited on foreign substrates. These layers have also been observed to survive high temperature thermal cycling in spite of wide differences in thermal expansion coefficients.

The goal of this project is to develop processes for the deposition of thin films of refractory compounds, such as pyrolitic boron nitride (PBN), titanium diboride (TiB2) and silica carbide (SiC) onto silica surfaces of various geometrical configurations. The coatings must include less than 5 ppm metallic impurities and survive ten cycles from room temperature to 1300 degrees Celsius.

AF87-055. TITLE: Ultra Narrow Linewidth Optical Source

OBJECTIVE: To develop methods of implementing narrow linewidth semiconductor laser subsystems of small size.

DESCRIPTION: The trend to future all optical systems mandates the need for ultra stable optical components. Many passive electronic components, e.g., waveguide or cable are replaced by active components e.g., lasers, optical waveguides and detectors in optical systems. Ultra stable narrow linewidth sources are at this time some form of gas laser. Future integrated photonic systems, to be cost effective and of small size, will necessarily require semiconductor lasers. Stablization to achieve narrow linewidth requires the use of large (10-20 centimeters) external cavities, which mitigate against small size. Work is necessary to develop methods of implementing narrow linewideth semiconductor laser subsystems of small size. Goals are linewidths of 1 Hz, wavelengths in both visible and infrared (.6 micron, 1.3 micron) and ultra small physical dimensions with semiconductor lasers. Modulation rate capability of serveral Gigahertz is also necessary.

AF87-056. TITLE: Probability Computations of Upset in Devices Due to Electromagnetic Effects

OBJECTIVE: To utilize state-of-the-art methods, all or in part, in a reverse engineering manner to develop an approach to compute the probability of upset due to electromagnetic effects.

DESCRIPTION: Current analyses, tests and predictive methods for complex, high speed, digital devices, qualify the operation of these devices under prescribed conditions. These methods include, for example, test vector generation stuck-at fault analysis, built-in tests, and the use of simulation programs such as LISP, LOGLISP and PROLOG. The objective of this proposed investigation is to utilize these methods, all or in part, in a reverse engineering manner, to develop an approach to compute the probability of upset due to electromagnetic effects. That is, normal device operation is impaired when extraneous signals from the electromagnetic environment are coupled to the input pins of complex, high speed, digital devices. In one possible approach, each pin can be assigned a probability of upset as a figure of merit to determine possible degradation during subsequent applications. The investigation should consider the use of expert systems technology.

AF87-057. TITLE: Reliable Microwave Laser Diodes

OBJECTIVE: To concentrate on developing a microwave laser structure which has 20 gigahertz bandwidth and high reliability.

DESCRIPTION: Significant advances are being made in the development of semiconductor lasers which can be directly modulated at microwave frequencies. Work on these lasers has focussed on structures which provide the highest bandwidth without concern for reliability. This effort should concentrate on developing a microwave laser structure which has 20 gigahertz bandwidth and high reliability. The wavelength of this laser should be 1.3 micrometers. It is desired to house the laser in a pigtailed microwave package which contains appropriate microwave and bias circuitry. This program is aimed at producing a useful transmitter module which can operate in a military environment. The offeror should have in-house facilities for fabricating high speed laser diodes.

AF87-058. TITLE: Improved Epitaxial Deposition Techniques for III-V Compounds

OBJECTIVE: To design an epitaxial system that will combine the optimum operating parameters of both III-V Compounds.

DESCRIPTION: This project includes research on the epitaxial growth of compound semiconductor thin films that will serve as the basis for advanced C(3)I systems. Molecular Beam Epitaxy (MBE) offers a high degree of control on layer thickness and uniformity, but suffers from limited throughput capability Band run-to-run reproducibility. Metal Organic Chemical Vapor Deposition (MOCVD) solves the throughput deficiency and operates in the same low temperature environment, but the control of layer thickness for quantum well structures is not as good as MBE's.

We are seeking innovative design solutions for an epitaxial system that will combine the optimum operating parameters of both of these techniques, while at the same time reducing the cost and complexity of operation. The design solutions must provide a cost effective, technically superior approach to growth of III-V materials having multiple Group V and Group III components.

AF87-059. TITLE: Fiber Optic Sensors of Electrical and Magnetic Fields

OBJECTIVE: To develop sensors capable of detecting very weak electrical/ magnetic fields over a frequency range extending from Kilohertz to approximately 10 GHz.

DESCRIPTION: The application of fiber optic sensor technology to the problem of electromagnetic field detection promises to considerably exceed the sensitivity/bandwidth performance of conventional detectors and will, therefore, be of importance to a variet of DoD signal processing and intelligence programs. In particular, fiber optic sensors have the advantage of being non-metallic, thereby minimizing the perturbation of the field being measured, and theoretical calculations indicate usable sensitivity over a very

large frequency range. Sensor concepts and technology capable of detecting very weak electrical/magnetic fields over a frequency range extending from Kilohertz to approximately 10 GHz are being sought. Research and Development, Test and Evaluation (RDTE) in the following topical areas will be considered: materials engineering (suitably sensitizing a fiber optic sensor via a material interface optimized for particular field parameters), novel sensor concepts and designs (interferometric/non-interferometric, directional response, polarization sensitivity, etc.), and the realization of fiber optic sensors which are sufficiently rugged to withstand the operational environment while demonstrating sensitivity/frequency range/detection bandwidth performance superior to conventional electrical and magnetic field detectors. Novel processing concepts which operate directly upon the optical output of such fiber optic sensors (e.g., optical correlators) will also be considered.

AF87-060. TITLE: Text Understanding

OBJECTIVE: To develop computer comprehension of natural language.

DESCRIPTION: At present, computer comprehension of natural language is in a very early stage. Even rudimentary 'understanding' within limited domains for particular purposes, would be of value. For example, Key Word in Context (KWIC) document retrieval systems are well-known. Document indexing for retrieval using more sophisticated retrieval semantic processing would be of more value.

A subset of English with restricted syntactic and semantic rules is an alternate attack on a portion of the problem. The goal is to write reports that can be automatically entered in a message database and be related to other messages by meaning. Software to assist in composing these limited messages would also be of value.

More sophisticated examples are to permit a system to react to the semantic content of documents; to automatically screen incoming text for items of interest; to perform initial matching of persons to jobs; to retrieve specific information from document data bases.

AF87-061. TITLE: AI and Ada for Decision Support Systems

OBJECTIVE: To define a hardware/software architecture and methodology, which link the aspects of Ada with the rapid protoyping development process associated with AI applications.

DESCRIPTION: This effort shall define a hardware/software development archietecture and the methodologies, which link the aspects of the Ada development environment with the rapid protoyping development process associated with AI applications development. Capabilities sought are novel approaches to meld Artificial Intelligence and the constructs of the Ada language to create an environment for the development, integration, and configuration management of complex systems involving C3I Battle Management Decision Aids/Decision Support Systems. The pivotal technical questions are:

1) how can aspects of the Ada development environment be linked with a rapid prototyping development process associated with Artificial Intelligence applications development, and 2) how might these concepts and techniques be advanced to transform the Decision Aid development process into a creative change process consisting of configurable elements using reusable components.

AF87-062. TITLE: Network Schema Server

OBJECTIVE: To fabric and demonstrate a Local Area Network (LAN) resident network schema server.

DESCRIPTION: Perform an implementation study leading to the fabrication and demonstration of a Local Area Network (LAN) resident network schema server. The network schema is the aggregate of all LAN resident data base schemas. Each class of user is assigned a unique network subschema. Network subschemas reside in a network resident server and are downloaded to the user's workstation upon sign-on/authentication. Users generate queries against their network subschema and the network shema server decomposes their query into subqueries, which are routed to specific data bases. Each constituent Data Base Management System (DBMS) is responsible for their individual subquery response. Subquery responses are aggregated by the network schema server and forwarded to the user submitting the query.

Under SBIR Phase 2, a contractor would build a LAN resident network schema server and identify all resources required to support it. Data administration and distribution, as well as communication and manpower issues will be addressed. The result will be a capability which the government can then transition to operational users.

AF87-063. TITLE: Programmable Optical Spatial Filters

OBJECTIVE: To exploit device technologies for programmable optical spatial filters for purposes of optical excission.

DESCRIPTION: The complex signal environment encountered on ELINT missions is placing increasingly stringent demands on automatic identification, wideband recording etc. Dynamic Range requirements in excess of 60 db, spurious and interferring signals, jamming signals, etc. are cluttering an already dense environment. One alternative to accomodate these interferring anomalies is the use of optical excission. This effort will exploit device technologies for programmable optical spatial filters for purposes of optical excission.

AF87-064. TITLE: Application of Modern Mathematics to Theater Air Warfare Intelligence

OBJECTIVE: To quantify the effectiveness of intelligence data, particularly as applied to combat situations.

DESCRIPTION: A need exists through the application of advanced mathematics to quantify the effectiveness of intelligence data, particularly as applied to combat situations. Effective intelligence has the attributes of maximum amount of information per data volume, completeness, accuracy, and validity. A number of new mathematical techniques may offer methods for quantifying the effectiveness of intelligence information. Consideration should be given to such techniques as information theory, fuzzy set theory, and methods for solving ill-posed inverse problems, etc.

AF87-065. TITLE: Analysis of Process Induced Damage In III-V Compounds

OBJECTIVE: To develop a method to characterize process induced damage in III-V Compounds.

DESCRIPTION: Advanced electro-optical devices composed of III-V and II-VI compounds are severely limited by the quality of the bulk substrates. Wafer processing techniques, such as cutting, lapping, mechanical polishing and high temperature annealing that have been successful in silicon technology cannot be applied to these compounds without serious degradation. It has been reported that the damage incorporated during processing can be more significant than all the defects that accompany bulk crystal growth. Electronic devices produced from these improperly prepared substrates have limited efficiency and sharply reduced life expectancies.

The brittle nature and thermal volatility of these substrates demand a new approach to processing and characterization. The ability to characterize the process induced surface and sub-surface damage is critical to advanced device technology.

Two primary goal of this effort is to develop a rapid non-destructive method to characterize process induced damage.

AF87-066. TITLE: Hazard Response Modeling Uncertainty

OBJECTIVE: To develop methodologies to quantify the uncertainty associated with use of microcomputer-based hazard response models.

DESCRIPTION: The U.S. Air Force has a need to quantify the uncertainty associated with use of microcomputer-based hazard response models. In the event of an accidental release of toxic gases to the atmosphere, a "toxic corridor" is calculated, based on output from an atmospheric diffusion model. The toxic corridor delineates the area requiring protective action (such as evacuation) due to gas concentrations exceeding specified limits. Model users need to know the uncertainty associated with calculating the toxic corridor; that is, they need to know the certainty that the gas concentrations of interest will be contained within the calculated corridor.

The current Air Force operational atmospheric diffusion model, the Ocean Breeze/Dry Gulch (OB/DG) equation, is an experimentally derived method on a large number of test releases of a neutrally buoyant tracter. Because it is

based on a large number of releases, confidence factors can be determined for its use, assuming the equation is used with scenarios identical to the releases used in its development. Newer models, operated on microcomputers, have been developed as potential replacements for OB/DG, which can be calculated manually with nomograms. The newer models incorporated improved model physics and include evaporation algorithms and techniques for simulating the release of heavier than air gases, while OB/DG does not. Despite these improvements, there is no straightforward way of calculating the uncertainty associated with these models. This uncertainty must be quantified before they can achieve widespread use within the US Air Force.

The effort envisioned would involve evaluating currently available microcomputer-based hazard response models. Based on this evaluation, methods would be developed to quantify the uncertainty associated with their use in various scenarios. The methods used to quantify the uncertainty could then be employed by Air Force personnel to evaluate other models for potential Air Force use.

AF87-067. TITLE: Modifiers for Asphalt Concrete

OBJECTIVE: To investigate these new materials for purposes of limiting distress due to high pressure tires and thrust vectoring.

DESCRIPTION: Current and future generations of aircraft require high pressure tires and thrust vectoring for short takeoff and landing (STOL) capability. The impact of these developments on asphaltic concrete airfield pavements will be detrimental. However, new technology has identified extenders, modifiers, and alternate binder materials which seemingly offer improvements over conventional asphalt cement. This task would investigate these new materials for purposes of limiting distress due to high pressure tires and thrust vectoring. In addition, the feasibility of these products needs serious attention as their costs could become uneconomical.

AF87-068. TITLE: Fire Suppressants for Composite Materials

OBJECTIVE: To develop new or modified fire suppressants to effectively control and extinguish composite materials.

DESCRIPTION: New and planned aerospace aircraft are being constructed of composite materials which undergo uncommon reactions in fire incidents. Their decomposition presents potential damage capability to electronic components being exposed and a potential health danger to humans in the vicinity of the composite materials decomposition. Burning characteristics and fire suppression techniques may be different than those of known materials also. This effort shall identify the decomposition and burning characteristics of composite materials, evaluate effectiveness of current fire suppressants in suppressing fires involving composite materials and develop new or modified fire suppressants to effectively control and extinguish this type of fire and its potential collateral damage.

AF87-069. TITLE: Stochastic Methods in Protective Structures

OBJECTIVE: To review and analyze current stochastic process methodologies for their applicability to protective structure designs.

DESCRIPTION: Current procedures for designing Air Force facilities to withstand nonnuclear weapons effects do not fully consider potential variations in loading mechanisms (delivery accuracy, weapon reliability, etc.), site characteristics, structural behavior, etc. Resulting designs tend to be very conservatively formulated, reducing opportunities to perform appropriate cost-benefit analyses. This effort shall provide a review and analyze current stochastic process methodologies for their applicability to protective structure designs and extend those basic methodologies to the unique load and response mechanisms associated with nonnuclear weapons efforts. Follow-on work would extend the basic methodologies to developing appropriate algorithms for structural design procedures.

AF87-070. TITLE: Leak Detection by Acoustic Emission Monitoring

OBJECTIVE: To develop new methodology to detect leaks in underground storage tanks and pipelines.

DESCRIPTION: The Air Force needs methods to detect leaks in underground storage tanks and pipelines. The acoustic emission (AE) monitoring has already been tried for internal testing of underground storage tank (UST) leak detection, but needs to be developed as an external leak detection device for tanks and pipelines. This technique could replace current methods based on chemical tracing and sampling groundwater. The AE technique could also be developed for tracking direction of migration and quantifying the leak, depending upon the liquid and the vessel material characteristics. The technique requires research on a variety of liquids, especially petroleum fuels, fuel tanks, and surrounding soil characteristics. Compared to conventional techniques, it is expected that AE techniques would be faster, safer, and could detect smaller leaks (less than 0.01 gal/hr.) from any of tanks and pipes.

AF87-071. TITLE: Increase Throw Range of Gaseous Fire Suppression Agents

OBJECTIVE: To develop an effective means to increase the throw range and vapor concentration of the gaseous fire suppression agents.

DESCRIPTION: Currently gaseous fire suppression agents of the HALON family have limited throw range, usually less than 50 feet. This limitation is caused by their physical property in that they vaporize when discharged and are affected by wind conditions. These two factors result in undesirable limitations in the use of these agents. Developing an effective means to increase the throw range and vapor concentration of the gaseous fire suppression agents is the objective of this research project. Longer throw range, greater concentration of fire suppression agent on the fire, and overcoming the effects of the wind would greatly improve the fire suppression capabilities of the HALON fire suppression agents.

AF87-072. TITLE: Gravity Effects in Small Scale Structural Modeling

OBJECTIVE: Develop concepts and procedures that compensate for gravitational effects without using artificially-induced gravity.

DESCRIPTION: In developing design criteria for structures designed to withstand nonnuclear weapons effects, the Air Force performs research through combining structural analysis with actual structual testing with weapons effects. This live testing may be either full-scale or at reduced scale; the reduced scale is more economical. Straightforward similitude analysis indicates that small scale structural dynamics tests should include artificially induced gravitational effects that vary inversely with the geometric scales used. Recent small scale structures tests with explosives in geotechnical centrifuges have shown gravitation effects to be influential on soil and structural responses. This effort shall analyze the many variables in small scale structures (both buried and above-ground) tests that use scaled nonnuclear weapons detonations; identify the variables most influenced by gravitational effects; and develop concepts and procedures that compensate for gravitational effects without using artifically-induced gravity (i.e., centrifuges). For example, soils used in models might be artifically stiffened in some manner. Follow-on efforts would test the procedures developed in the initial task and compare the test results with small scale models in centrifuges and full scale tests.

AF87-073. TITLE: Helmet Mounted Eye Position/Orientation Sensing for Aircraft Cockpits

OBJECTIVE: To evaluate applicable technology and perform early development of a miniturized, lightweight system that will accurately record eye position/orientation in both anticipated operational cockpit environments and the current Visually Coupled Airbourne Simulator System (VCASS).

DESCRIPTION: The AAMRL virtual cockpit concept includes three key features: 1) Use of eye line-of-sight to control aircraft functions, 2) use of eye movement and fixation data as indicators of acceptability of candidate cockpit displays, and 3) use of eye parameters to deduce "pilot state" and modify the pilot interface to controls and displays. Products will include evaluation of state of the art eye position/orientation systems, innovative algorithms for improving error/repeatability/ resolution/processing rates, and design for transducers and compatible helmet display systems. The following steps should be considered in the development of an optimal technological approach to this problem: 1) Generate list of performance requirements and goals. 2) Review and categorize eye position sensing techniques. 3) Investigate current emitters and sensors. 4) Review processing algorithms. 5) Investigate required computer hardware/software. 6) Perform optical design integration study. 7) Identify functional and performance characteristics. 8) Separately document operational and VCASS designs.

AF87-074. TITLE: Rapid Measures of Brain Activity to Assess Operator State

OBJECTIVE: To develop methods whereby the response to single stimuli can be used or the ongoing activity from the brain can itself provide sensitive and accurate estimates of operator state.

DESCRIPTION: There is increasing need to develop sensitive predictors of impending decrements in operator performance before there is an impact on a mission. Methods of rapidly assessing operator state are becoming crucial as systems become more complex and require operators to handle increasingly large amounts of information and rapidly make decisions. The possibility of impending performance breakdown can be provided to the operator, the system or someone in the command structure so that appropriate actions may be taken. Physiological measures show some promise of providing such predictive information. Electrical activity from the brain has the potential to provide a sensitive measure of operator state. However, the currently available methods of measuring brain activity typically require a number of discrete stimuli in order to have enough data. Methods are required whereby the response to single stimuli can be used or the ongoing activity from the brain can itself provide sensitive and accurate estimates of operator state. These new techniques could also include novel ways of recording brain activity such as placing the electrode, amplifier and transmitter all in one very small unit. Analysis procedures in which evoking stimuli are not used could be especially valuable if reliable techniques were available to extract meaningful information from the ongoing brain waves. In order to gain acceptance these techniques would be required to be nonintrusive into the operator's primary task and be innovative in terms of hardware and/or software. Validity, reliability and field acceptance must be demonstrated.

AF87-075. TITLE: Pressure Suit Cooling Garment

OBJECTIVE: Develop an easily donned, lightweight garment which incorporates a cooling (or heating) device separated into body segments and an autofeedback mechanism for regulation of each segment independently.

DESCRIPTION: Many types of cooling garments exist, the most notable being the liquid-cooled type used inside space suits and under chemical protective clothing. Although these work reasonably well to prevent overheating, they fall short as regards user comfort. In a situation where workload and thermal load may vary, the system must be manually adjusted to regulate the appropriate amount of cooling. This cooling is delivered to all parts of the garment uniformly. Particularly in space suits, this design often results in one or more parts of the body (usually hands or feet) being too hot or too cold. The desired system would consist of an easily donned, lightweight garment which incorporates a cooling (or heating) device separated into body segments and an autofeedback mechanism for regulation of each segment independently. There must be a biomedical (? skin temperature) sensor for each segment. A manual override for each segment is necessary. The system must be capable of interface with an external device or aircraft system which would act as a heat exchanger. Consideration of a non-vented system for heat exchange is desirable, as current sublimation techniques could contaminate sensitive on-orbit equipment.

AF87-076. TITLE: Lightweight Chiller Efficiency Improvements

OBJECTIVE: Develop more efficient lightweight chiller devices to reduce their weight and energy consumption.

DESCRIPTION: Vapor cycle refrigeration devices are being developed to chill a water-glycol mixture and air which circulates through a vest worn by personnel facing thermal burden due to their environment or heavy clothing they must wear. These devices are either worn on the back, app. 15 pounds, or stand on the ground and cool several users at a time; 25 to 150 pounds. More efficient devices are needed to reduce their weight and energy consumption. Several approaches may exist. 1) Rather than have a water-glycol mixture circulate through a vest, have the refrigerant go directly to the vest and thereby eliminate the refrigerant/water heat exchanger and water pump. This has been attempted, but when the system is shut off the refrigerant creates great pressures as it warms, damages the vest, and leaks out. Suggest either improved vest design or a pump-down sequence upon shutting the system off. 2) These devices are currently using refrigerant #12. Since the personal vest should never be colder than 60°F, a different refrigerant may be the optimum type. 3) When these devices are used in high temperatures the refrigerant condensors are inherently less efficient. Suggest a condensor be developed which can employ both its normal air convection cooling and optional evaporative water cooling, i.e., minimum cooling tower. 4) Suggest benefit/cost determination of using a turbine pre-compressor by dropping the freon's high pressure across a turbine rather than a capillary. This method is known as the reverse Brayton cycle.

AF87-077. TITLE: Development of Helmet-Mounted EEG Transducer System.

OBJECTIVE: To develop helmet-mounted transducer system to acquire recordings of EEG in humans during flight.

DESCRIPTION: Acquiring recordings of EEG in flight in humans presents several problems. Artifact presence in the record due to body movements, especially head movement, results in data records which border on the useless. Providing a stable base for recording transduces itself when using scalp electrodes requires firm placement of the electrodes on the head. Currently, a messy and only marginally acceptable method is used for this procedure. This entails using Collodian (removed by dissolution in acetone) gauze pads and tape. An inductive capacitance system which positions the electrode near the scalp but does not require scalp contact is desirable. Incorporation of an array of electrodes and preamplifiers into the currently approved flight helmet is sought.

AF87-078. TITLE: Neuro-Magnetic Signal Processing

OBJECTIVE: Design an optimum neural-magnetic estimator.

DESCRIPTION: Monitoring the physiological behavior of a cognitive process opens many opportunities to study how the human brain processes information. To reliably identify and track a neuro-process through neuro-magnetic

measurements, the measured field must be analyzed in both time and space. The signal processing of neuro-magnetic fields, however, is severely hindered by fundamental barriers. Time domain processing suffers from the classical problem of low signal-to-noise ratios. Although line filters, environmental shielding, and careful experimental techniques will eliminate much of the signal corruption, uncorrelated noise from within the brain tissue corrupts the desired response to an unacceptable level. The first part of the task is to describe the dynamics of the surrounding brain activity detection at fixed measuring positions over the scalp, and use this information to design an optimum neural-magnetic estimator. Both the desired signal and the noise must be described for optimal results. Even if perfect neuro-magnetic signals are measured outside the scalp, the task of completely describing the responsible source is impossible as a result of the fundamental law of superposition. Therefore, the second part of the task is to develop spacial processing techniques to logically estimate the location, shape, and strength of the source responsible for the detected magnetic field. Required considerations include the size and shape of the human cranial cavity, anatomical structure of the cerebral cortex, and expected errors due to model inadequacies.

AF87-079. TITLE: Chemical Detection and Alerting Systems

OBJECTIVE: Develop fieldable, rugged, sensitive, selective, and inexpensive detection and alerting systems based on optical and chemically-electronically coupled analytical techniques.

DESCRIPTION: Defense against chemical warfare agents requires sophisticated sensors that quickly detect, identify, and monitor very small concentrations. The sensors require a short response time in order to minimize casualties and a low false alarm rate to maintain credibility. Specific needs are for fieldable, rugged, sensitive, selective, and inexpensive detection and alerting systems based on optical and chemically-electronically coupled analytical techniques. Sensor chemistry, coating development, and material science are of equal or greater importance than basic hardware design.

AF87-080. TITLE: Situational Awareness Training

OBJECTIVE: Develop a training program to enhance situational awareness in USAF operational pilots.

DESCRIPTION: The Clinical Sciences Division of the USAF School of Aerospace Medicine is seeking innovative development of a training program to enhance situational awareness in USAF operational pilots. Situational awareness is that attribute of the superior pilot which allows him to have comprehensive, detailed and up-to-date knowledge of an engagement arena at all times without disrupting his focused attention on the task at hand. The taxonomy of situational awareness has been developed and will be provided to the successful bidder(s) for guidance. The effort will require a team with skills in the behavioral sciences, educational methodology, and graphics/display computer sciences as well as resource personnel with

fighter pilot experience. The USAF application must facilitate Aircrew Combat Mission Enhancement. The phase I proposal should address migration of the technology to the civilian marketplace. This announcement may result in multiple awards, in order to consider a phase II award based on competition.

AF87-081. TITLE: Characterization and Application of Quaternions for Enhanced Computer Processing Algorithms

OBJECTIVE: Develop a reference text for practicing DOD and contractor technical personnel.

DESCRIPTION: The problem of computing multiple coordinate transformations for rigid body motions in aircraft, for predictive missile and threat analysis algorithms, and for ground-based simulation and terrain portrayal displays is one that is encountered time and again in Air Force operations. These processes are still performed using primarily Euler angle and direction cosine formulations which place significant runtime overhead on digital computers. Quaternion formulations of three-dimensional space significantly reduce computer processing time, need only four elements instead of the nine required for direction cosines and do not suffer from singularity problems encountered when using Euler angles. Given the potential wide application and benefits to be derived from the use of quaternion-based algorithms, it is highly desirable to develop a reference text for practicing DOD and contractor technical personnel. The text would cover both the theoretical aspects to allow the user to insert such analytical techniques into the initial concept formulation phase of applicable technical efforts as well as specific applications so that the merits of quaternion algorithms can be clearly understood and applied. In particular, the theoretical aspects of quaternions relating to their properties, algebraic structure, calculus (including derivative and differential concepts), and their geometric characteristics shall be covered. Liberal use of pictorial representations shall be made to facilitate efficient information transfer to the user. The reference text shall also include a thorough discussion of general application areas and several in-depth developments.

AF87-082. TITLE: 3-Dimensional Virtual Group Awareness (VIRGA) Workspaces for Battle Management

OBJECTIVE: Develop a 3-dimensional workspace that enhances the direct manipulation interface for the user.

DESCRIPTION: There exists a need to create a 3-dimensional workspace that enhances the direct manipulation interface for the user. Inherent in the battle management situation is the need for distributed C3 between individual workspaces. Thus there must exist a means for communicating, fusing, and sharing pertinent information so as to network these integrated, yet geographically separated, workspaces. The 3-dimensionality of the workspace must come about by creating a visually recombinant architecture, i.e., an architecture surround that is constructed by recombination of the graphical and holographic members that build up unique, dynamic workspaces

for the battle management commander. By networking their individual workspaces, commanders are provided with a Virtual Group Awareness (VIRGA). The technology that underlies this workspace initially would consist of an integrated mix of holographic displays, large flat panel displays, intelligent iconic software, information retrieval systems, computer animation, optical video disc systems, direct manipulation interfaces and advanced video teleconferencing/interactive television systems. The combinations of technology would allow the commander as well as icons, holographs, computer animations, auditory perceptions, and written materials to appear in other workspaces interactively. A series of tradeoff studies and evaluations must be conducted to assess the proper mix, usage, and development of the aforementioned technologies. Areas where technology does not support the VIRGA concept from these current research areas should be identified. Candidate technologies should be demonstrated to determine the feasibility of including them in workspaces. Results of these studies and demonstrations will initialize the first level concept of a VIRGA workspace. A prototype will be specified using currently available technology. Phase II of this effort will require that the prototype be constructed and demonstrated as an integral unit to justify the tradeoff study decisions in terms of an efficent human interface.

AF87-083. TITLE: Intelligent Systems Technology

OBJECTIVE: To develop modules and tools for the human-computer interface that will facilitate training and job-aiding applications.

DESCRIPTION: Artificial Intelligence research is focusing on emerging technologies for applications in Air Force training. Intelligent Tutoring Systems (ITS) represent an ideal technique to train Air Force personnel in the future. An ITS requires designing and developing an intelligent tutor to demonstrate the capabilities of ITS for training. The deliverables include ITS design specifications, source code, and a demonstrable intelligent tutor, which should run on a Symbolics 3670 or a Xerox 1108. Another area of interest is to develop modules and tools for the human-computer interface that will facilitate training and job-aiding applications. Specific objectives include: (1) the development of "dictionary" acquisitions from text software, (2) the development of a design for a simultaneous rule formalism, and (3) the exploration of designs for the interface between the simultaneous rule formalism and an object-oriented data base system. All deliverables must run within the Symbolics 3670 or Xerox 1108 environments, and complete documentation must include exposition of the algorithms that are used.

AF87-084. TITLE: Improved Combustion Toxicology of New PF-11 Chemicals

OBJECTIVE: Develop methods to assess the toxicity of thermal degradation products from a multitude of new chemicals that may be developed under Project Forecast II (PFII).

DESCRIPTION: Improved methods are needed to assess the toxicity of thermal degradation products from a multitude of new chemicals that may be developed under Project Forecast II. Research is required that can validate improved

techniques for accurately and rapidly evaluating the toxic hazard posed by human exposure to thermally decomposed materials. Current methods only measure a limited number of endpoints (usually lethality) and/or provide a less-than-comprehensive chemical analysis of combustion products that are difficult to interpret and relate to biological effects. Both approaches are usually time-consuming, relatively expensive, and provide suboptimal results to produce a confident risk assessment for human exposure to materials undergoing pyrolysis or flaming. Better combustion toxicity information and capability is needed to evaluate the hazard of many new chemicals and materials that are envisioned for use in the Air Force's Project Forecast II program. An NBS style combustion exposure chamber should provide the capability to measure as many relevant biological endpoints as possible. A real-time quantitative and qualitative chemical analysis such as FTIR should accompany the animal exposures.

AF87-085. TITLE: Night Vision Goggles for the Tactical Crewmember

OBJECTIVE: Development of night vision image-intensification goggle that is compatible with the tactical crewmember's environment.

DESCRIPTION: Because of the lack of a system to satisfy the fighter community's needs, certain night-time missions cannot be carried out safely. For this reason a need exists for the development of a night vision image-intensification goggle that is compatible with the tactical crewmember's environment, specfically, a goggle which is ejection safe, windblast safe, high "G" safe, and compatible with the ACES II ejection seat. Additional requirements are that it be light weight to minimize fatigue and capable of ground operations, i.e., escape and evasion subsequent to ejection. Ideally, the system would be compatible with the Tactical Life Support System, an advanced development program managed at the Aerospace Medical Division, Brooks AFB TX. By doing so, the Air Force could procure a system which provides enhanced protection from hostile environmental conditions such as high "G" high altitude, high temperature, laser, and nuclear flash, as well as provide the added benefit of night vision.

AF87-086. TITLE: The Recovery of Depth Information in the Human Visual System

OBJECTIVE: Investigate specific signal processing concepts within the basic framework of the human information processing system.

DESCRIPTION: The purpose of this project is to investigate specfic signal processing concepts within the basic framework of the human information processing system. It is intended that this project be based upon recent research including the areas of modeling of human visual image processing and perception, computer vision, and signal processing. With this background, the project is intended to extend the model of the human visual system somewhat into the cognitive realm. It is not intended that the human system be modeled entirely or even exactly. However, the basic interactions of the components of the human information processing system will be modeled

to the extent that they affect the signal processing aspects of the problem. This can best be explained by example. The projects focus might be explained as investigating the algorithms to be used by a machine which is to identify objects in its sensory environment much like a human might, as opposed to modeling exactly how a human would process that same sensory environment. The difference being that the design of the machine is not to be an identical copy of the human system, but use aspects of the human system which enhance system performance. Specifically, this project shall investigate the signal processing aspects of the multi-sensor input of visual information to the human vision system with regards to the perception of stereopsis in static and dynamic environments. In a sense, this is a classical signal processing problem in that the human visual system may utilize two highly-correlated images sampled at the retina to generate one perceptual scene which contains an extracted information array of depth. The modeling of this process utilizing signal processing techniques is the objective of this research.

AF87-087. TITLE: Composite Materials for Manikin Skeletal Components

OBJECTIVE: Investigate the feasibility of using composite materials for specific structural elements of a manikin.

DESCRIPTION: Modern manikins, such as the Hybrid III, are fabricated of a skeleton of metal bones to provide the structural strength required for high accelerations and loads testing. Such metal structures considerably constrain the ability to achieve both proper segment inertial distribution properties as well as load-deformation properties of load transmitting members. This makes it more difficult to design manikins for biofidelic response. For this reason, it is highly desirable to investigate the feasibility of using composite materials for specific structural elements of a manikin. Such materials have a higher strength to weight ratio and have more bone-like deformation properties than currently used metal parts. The objective of this program is to develop prototype manikin skeletal components, such as the long bones, fabricated of composite materials. This will make it possible to achieve segment inertial distribution properties as well as overall biofidelic response. The approach will entail the selection of the appropriate composite materials, design of the skeletal components and their fabrication. These prototypes will be incorporated into an existing manikin on which dynamic testing will be performed. This program will demonstrate the use of skeltal components fabricated from composite materials in state-of-the-art manikins to provide improved biofidelic response.

AF87-088. TITLE: Diagnostic Rules Generator

OBJECTIVE: Develop expert system(s) for the generation of rules for the analysis of nuclear medicine, photographic camera, microfiche, etc., images and physiological analogue signals of medical diagnostic significance.

DESCRIPTION: The Clinical Sciences Division of the USAF School of Aerospace Medicine is seeking innovative research and/or engineering development of an expert system(s) for the generation of rules for the analysis of nuclear

medicine, photographic camera, microfiche, etc., images and physiological analogue signals of medical diagnostic significance including but not limited to the electrocardiogram, blood pressure, respiration, electrogastrogram, and electromyogram. Rule induction based on examples or analogies provided by physicians evaluating such images and physiologic signals should be a feature of such a system. Some artificial intelligence features or the capability to develop toward artificial intelligence *downstream* should be a feature. The objective is to capture and institutionalize the best diagnostic "rules" of the best clinicians over a period of several years, but is not to make diagnoses per se. The product of this effort should make a contribution to the larger R&D arena of Knowledge Based Systems. The phase I proposal should address migration of the technology to the civilian marketplace.

AF87-089. TITLE: Chemical Agent Filter Test for Channeling

OBJECTIVE: Develop a test that can detect channeling before filter use but would not degrade the chemical agent protection.

DESCRIPTION: Chemical agent filters that develop channeling due to improper manufacturing or handling can have a reduced life span. Unless channeling can be detected before use, the protection time given by a filter becomes questionable. The results of this effort would be a test that can detect channeling before filter use but would not degrade the chemical agent protection.

AF87-090. TITLE: Unified Life Cycle Engineering

OBJECTIVE: To develop supportability tools for Unified Life Cycle Engineering.

DESCRIPTION: The Air Force has initiated several efforts to develop an engineering environment in which all design related end-product attributes are integrated and optimized with computer-aiding engineering (CAE) tools during the active design process. This process, termed Unified Life Cycle Engineering (ULCE), encompasses designing for performance, producibility/ manufacturability, supportability (reliability, maintainability, testability, etc.), cost, schedule, etc.

The Air Force is interested in obtaining viable, yet innovative ideas in the form of Phase I proposals that specifically address the development of software and/or computer-related techniques to accelerate the defense industry's inclusion of supportability design considerations into ULCE processes. Among key technology thrusts are: (a) computerized design rules developed from authoritative sources as well as lessons learned from field experience; (b) dealing with distributed data bases in the collection, repository, distribution and application of design information and results of analyses to other users/computer programs; (c) tracking the rapidly evolving interface specifications for application in interfacing/ interacting/integrating commercially available supportability related software with each other as well as with CAE developments; (d) computerized tools with which the Air Force can evaluate supportability attributes and

specification compliance of a design during proposal evaluation and formal design reviews; (e) tools for assessing the applicability of military specifications to a particular development and assisting in their precise tailoring; (f) tools to assist in specifying design/performance attributes commensurate with supportability requirements and maintenance philosophy. Other applicable thrusts will be given equal consideration.

AF87-091. TITLE: Innovative Growth Techniques For Infrared Detector Materials

OBJECTIVE: Develop improved/low cost infrared detectors through advancements in detector materials and processing technology.

DESCRIPTION: Air Force requirements for improved infrared surveillance capabilities dictate a need for advancements in detector materials and processing technology. Mercury cadmium telluride and extrinsic silicon materials have a high potential for meeting anticipated detector performance at the highest possible temperature. New concepts such as heterostructures and superlattice detectors are solicited. Detector arrays are being driven to larger numbers of elements which places increased emphasis on needs for materials uniformity, reproducibility, and low cost processing. New techniques such as molecular beam and vapor phase epitaxial growth are currently being evaluated for meeting these requirements. New approaches to provide additional benefits in low cost processing and detector performance are solicited.

AF87-092. TITLE: Opto-Electronic Materials

OBJECTIVE: To develop concepts for obtaining materials with large interaction coefficients in useful configurations at low cost.

DESCRIPTION: Opto-electronic materials are required for optical image processing for radar and infrared systems and for optical computing. Concepts for obtaining materials with large interaction coefficients (i.e., highly non-linear) in useful configurations at low cost are sought. Inorganic and organic materials will be given consideration. Potential applications include elements such as waveguides for monolithic integration of sources, sensors and electronics on chip and spatial light modulators for input/output functions for optical computing.

AF87-093. TITLE: Fabrication of Microwave Device Materials

OBJECTIVE: To develop growth techniques for large, uniform crystals, the growth of low defect material, and the identification and optimization of appropriate evaluation techniques for both bulk material and wafers.

DESCRIPTION: Gallium arsenide based amplifiers and monolithic integrated circuits are finding increased use in military systems. A key for the fabrication of these microwave devices and circuits is the basic semi-insulating gallium arsenide materials that are used for device

substrates. Improvement is needed in several areas, including the following: the growth techniques for large, uniform crystals, the growth of low defect material, and the identification and optimization of appropriate evaluation techniques for both bulk material and wafers. Epitaxial film growth processes are also included as important crystal growth areas requiring improvement. The latter area includes the need for an identification of the material and wafer properties that have the greatest effects on device performance. Device and process modeling for microwave devices will aid in this identification. In addition, improved techniques for wafer preparation are needed.

AF87-094. TITLE: Assessing Fatigue Crack Growth Predicting Programs

OBJECTIVE: To develop analytical and experimental techniques for assessing the accuracy of fatigue crack growth predicting programs.

DESCRIPTION:

a. Many software programs are available for predicting the growth of cracks in structures subjected to spectrum loading. Both government and private industry provide and use these programs. Quite often, for ease of computation, very simplistic models are used in building the software which makes the accuracy of the predictions questionable. Minimum requirements for spectrum fatigue crack growth predicting programs should be identified. These requirements should consider as a minimum the way constant amplitude data are handled, method of predicting stress ratio effects, and the model used to account for load interaction. Methods should be developed to assess the accuracy of any program and these assessment criteria/techniques should be made available to the technical community.

b. Advanced, innovative approaches are needed for the development of improved nondestructive inspection and evaluation (NDI/E) techniques for the detection and characterization of flaws in airframe and engine materials including metals, composites, and ceramics, and for use in the real-time monitoring of aircraft structure manufacturing processes. In particular, innovative technical approaches are needed for the detection and characterization of bulk and surface defects in both metallic and nonmetallic structures, for the evaluation of the integrity of bondlines in bonded structures, for the determination of the condition of the matrix and reinforcing substructures in advanced composite structures, for the quality of high-temperature material coatings, and for the inspection and evaluation of electronic device materials and components. Technical approaches proposed must either achieve clearly significant improvements in the standard techniques or instrumentation currently being used in laboratory, factory and field inspections, or must identify new inspection and evaluation techniques which have capabilities far superior to those currently used and which have the potential for ultimate use in realistic manufacturing or in-service environments. Proposals addressing significant technical advances in all phases of the inspection procedure are solicited, from new sensors for the collection of inspection data to advanced NDE signal processing concepts and methods.

AF87-095. TITLE: High Temperature Liquid Lubricants

OBJECTIVE: To synthesize and characterize monomolecular perfluoroalkylether fluids as high temperature liquid lubricants.

DESCRIPTION: The work to be conducted consists of synthesizing pure, monomolecular perfluorinated polyalkylether fluids for which the structure and composition are well defined and their subsequent characterization for chemical and physical properties. Examples of the types of physical and chemical properties to be determined are: viscosity-temperature properties over the -54° to 316° C temperature range, thermal and oxidative stabilities using conventional ASTM and Federal Test Method Standard methods as well as new methods that are developed to determine a more thorough understanding of the behavior of these fluids under stress. Fluid samples of not less than 100 ml will have to be synthesized to provide adequate samples for property determinations.

AF87-096. TITLE: Properties of Materials at High Pressures

OBJECTIVE: To develop measuring techniques for chemical, physical and thermodynamic properties of solutions at pressures that are several hundred times higher than atmospheric pressure.

DESCRIPTION: The effort to be undertaken is to determine the feasibility of measuring chemical, physical and thermodynamic properties of solutions at pressures that are several hundred times higher than atmospheric pressure. Special emphasis would be placed on properties that affect solubility, surface activity on metal substrates and non-bonding interactions between compounds. In designing materials that will be effective as hydraulic fluids and lubricants, the properties of components and formulations are measured and studied at atmospheric pressures (14.7 lbs/sq. in.). Very little is known, however, about phase changes or other effects that may occur at pressures found in hydraulic systems where solutions are pumped at 3000 to 8000 lbs/sq. in. High pressure measurement of properties of some pure compounds have been measured using various spectroscopic techniques in conjunction with high pressure cells. However, the problem of determining the effectiveness of materials for corrosion inhibition, lubricity enhancement and viscosity improvement is not generally known except with the trial and error method of looking for possible degradation of the materials after load testing.

AF87-097. TITLE: High Temperature Solid Lubricant Technology

OBJECTIVE: To perform research of high temperature solid lubrication.

DESCRIPTION: The Air Force requires research in the following areas of high temperature solid lubrication:

a. Novel In-Situ Lubrication of Ceramics: Innovative approaches are sought for concepts which continually generate lubricious (low friction, low wear) species between the surfaces of ceramics moving relative to each other at high temperatures and high sliding speeds. Concepts for selection of ceramic

compositions that provide beneficial surface reactions when brought together under these conditions or incorporating active species that migrate to the surface and react are examples of ideas that should be proposed.

b. High Temperature Oxide-Based Solid Lubricants: Research is needed to develop candidate high temperature solid lubricant materials for operation in the 1000° - 2000°F temperature range in oxidizing environments. Concepts for materials based on soft or lubricious oxides that are thermally and oxidatively stable, yet have relatively low coefficients of friction are sought. Other important properties for these solid lubricant materials are the ability to bond to both metal and ceramic substrates, exhibit low wear over the 1000° - 2000°F temperature range, and be capable of being applied to the substrates in an economical manner. The research should consider the use of single oxide materials as well as two or more materials which may react at high temperatures to produce low friction, low wear materials.

AF87-098. TITLE: Synthesis, Characterization and Processing of New High Performance Polymers

OBJECTIVE: To develop new polymeric materials tailored in molecular structure to provide performance advantages over state-of-the-art materials.

DESCRIPTION: Research and exploratory development is sought to discover new polymeric materials tailored in molecular structure to provide performance advantages over state-of-the-art materials. Special interest is on new polymer systems with potential for the development of improved structural materials (e.g., molecular composites and fiber reinforced composites) and unique electro-optical and conductive materials. Polymers with exceptionally high use temperature and reasonably low energy requirements for curing and processing are needed. Areas of current emphasis include investigation of: (a) synthesis routes and methods to improve processing of rigid rod polymer molecular composites entailing the preparation of very thermally stable (600-700°F use temperatures) high polymer systems under reasonable processing conditions and without the evolution of impractical quantities of volatiles, (b) theoretical chemistry to provide fundamental understanding of the molecular requirements for achieving electro-optical and conductive processes in organic and semiorganic polymer systems, (c) processing and morphology of rigid rod-like polymers to discover approaches for achieving superior compressive strengths, and (d) polymer structure-property correlations to elucidate processing options for achieving desired morphologies and mechanical properties. Other approaches to provide polymer systems with potential for exceeding state-of-the-art performance characteristics are of interest.

AF87-099. TITLE: Nosecaps, Leading Edge, and Sensor Windows for Hypersonic Vehicles

OBJECTIVE: To develop low erosion, shape stable materials for maximum service temperatures of 4500°F.

DESCRIPTION: Future transatmospheric flight vehicles will be cyclic heated to high aero-temperatures and for long periods of time. Low erosion, shape

stable materials will be required for maximum service temperatures to approximately 4500°F. Carbon and ceramic matrix composites based on new constituents and processing methods are required to be incorporated into innovative component designs. Primary uses include nosecaps, leading edges and sensor (antenna) windows of hypersonic flight vehicles. Phase I would define the conceptual materials and approaches, screening experiments, and the major technological risks with an assessment of the probability of success. Phase II efforts would include reducing these materials compositions and constructions to practice in the form of composites and laminates (approximately 1 ft 2 each), high temperature constituent compatibility; iterative product development and evaluation to optimize composite properties and characteristics, and, selection of most promising composites for follow-on development. Follow-on efforts would fabricate multiple subscale articles, obtain engineering design data and conduct specialized testing to verify performance attributes and limitations.

AF87-100. TITLE: Lightweight, Aerostructural Composites

OBJECTIVE: Development of materials for 1800°F to 4000°F structural applications.

DESCRIPTION: Future Air Force hypersonic vehicles will require a variety of advanced composite materials for 1800°F to 4000°F structural applications. The development of these advanced composites would initially require an assessment of candidate composite components that would fulfill the high temperature, oxidation resistant, structural requirement. Phase I efforts would include both experimental and analytical investigations to examine fiber and matrix chemical and mechanical interactions; bulk components processing parameters and potential composite properties. Phase II would focus on fabrication of composite panels and specimens for mechanical and oxidation behavior evaluation at elevated temperatures and address potential payoffs/problems of large components to include thin wall and complex shape construction as well as material implications. Phase III would fabricate large, complex shape components representative of portions of a large aerovehicle that have critical structural and processing implications that could be structurally and environmentally evaluated for application identification.

AF87-101. TITLE: Structural Composite Processing and Properties

OBJECTIVE: Improved methodology for processing structural composites components.

DESCRIPTION: Development of one or more of the following technologies is needed in the area of aerospace materials processing and design.

a. The Air Force Materials Laboratory is interested in pursuing activities that can lead to an innovative and improved methodology for processing structural composites (including molecular composites) components. Such activities can include new means of processing; fundamental research that can lead to improved quality and reliability of components; and computer aided

systems, either for processing control or for simulation analysis of "ility" functions, in order to improve the "ilities" of the component during its life cycle.

b. The Air Force is interested in research and development directed toward applications of biotechnology to aerospace materials requirements. The objective is either lower cost processes for advanced materials or improved materials designs not otherwise obtainable. Either process or design concepts should lead to a marketable product for Phase III. This activity can include the following areas:

(1) Biosynthetic methods to provide state-of-the-art materials for Air Force applications utilizing resources that can be domestically produced. The biosynthetic methods may provide unique precursors which can be converted by conventional chemical methods to materials such as organic matrix resins for lightweight structural composites; carbonizable matrix resins for carbon matrix composites, lubricants, elastomers, electro-optic materials, ceramic or ceramic precursors, and pure metals for structural or electronic applications.

(2) Novel materials obtained from biological sources with properties that may satisfy current or future Air Force needs in areas such as those listed above. Examples would include carbonizable matrix resins with high theoretical char yield, modified ceramic exoskeletons which could be grown into a carbon matrix composite for oxidation protection, or materials with very rapid response to changes in light intensity.

(3) Biodegradation techniques appropriate to applications such as polyurethane paint stripping or integrated circuit etching.

AF87-102. TITLE: Heat Resistant Films and Papers for Toughening Composites

OBJECTIVE: Development of heat resistant films and papers for toughening composites.

DESCRIPTION: The incorporation of thin layers of tough resin films and polymeric fiber papers between plies of graphite fiber plastic prepreg greatly increases the impact resistance of the laminates. However, the temperature capability of such films and papers needs to be increased to approximately 500^{o}F. The films and fibers should have the following room temperature physical and mechanical properties (in the ranges and with the characteristics indicated):

a. Tensile modulus: 0.5 to 2.0 (x10^{6}) psi
b. Ultimate tensile strength (minimum): 50 to 100 (x10^{3}) psi
c. Elongation at rupture (minimum): 40 to 50%
d. Thickness of film or paper: 0.0005 to 0.001 inch
e. Withstand composite fabrication temperatures up to 500^{o}F
f. Adhere well to bismaleimide laminating resins
g. Resistant to fluids used in operating and maintaining aircraft

The work shall consist of preparing the films and papers by a prototype production process; determining properties of the films and papers; and demonstration of feasibility of incorporating the films and papers in laboratory scale graphite fiber bismaleimide composites. Proposals may address either the films or papers requirements, or both, depending on qualifications of the offeror.

AF87-103. TITLE: High Performance Aluminum, Beryllium, Titanium, Magnesium

OBJECTIVE: To develop approaches resulting in new rapidly solidified aluminum, beryllium, magnesium and titanium alloys.

DESCRIPTION: Unique approaches to result in new rapidly solidified aluminum, beryllium, magnesium and titanium alloys are required. Incorporated are ultra high temperature aluminum alloys to replace titanium for applications to 900°F and ultra high temperature titanium alloys to replace superalloy applications to 1800°F. Utilizing rapid solidification (RS) technology environmentally stable, ultra light magnesium alloys and beryllium alloyed to alter the normally hexagonal close-packed structure, are desired. Included is the response of these alloys to secondary processing. Rapidly solidified titanium alloy requirements are directed for improvements in three areas: temperature stability to 1800°F, strength to 210 ksi, and higher modulus/density ratio. Because of good specific strength and stiffness, magnesium alloys are potentially attractive for many aerospace applications. Research is now needed to explore property improvements, especially in the corrosion resistance of these alloys. Improvements in strength, stiffness, and a reduction in density may be possible using novel alloying additions. Approaches are needed in the following areas: development of an RS process for magnesium and beryllium alloys development; low cost consolidation techniques, and characterization of microstructure/mechanical property interaction. Magnesium/graphite metal matrix composites offer considerable promise for space applications because of their strength to density ratio and zero coefficient of thermal expansion. Low cost scaleable approaches are needed for fiber wetting, composite compaction and assembly. Matrix materials considered should be rapidly solidified to take advantage of unique property improvements available.

AF87-104. TITLE: Determination of Constitutive Parameters of Materials Subjected to Severe Environments

OBJECTIVE: To develop methods to determine fracture, fatigue, and constitutive characteristics of newly developed materials for high performance turbine engines, and advanced structures for aeronautical and space applications.

DESCRIPTION: Advanced methods, including innovative test techniques and unique apparatus, are needed to determine fracture, fatigue, and constitutive characteristics of newly developed materials for high performance turbine engines, and advanced structures for aeronautical and space applications. Emphasis will be placed on the testing of small samples to determine characteristics, such as failure modes, crack growth, modulus, and damping, as

a function of temperature and other environments under tensile, compression, and shear monotonic and cyclic loading. Typical material systems include titanium aluminides, nickel aluminides, ceramic matrix composites, and metal matrix composites. Phase I activity will include demonstration of feasibility through assessment of correlating parameters on selected materials. This will lead to Phase II activities of final development of techniques and apparatus including validation of data base for use for further material development and transition to advanced structural design.

AF87-105. TITLE: High Temperature Materials for Advanced Systems

OBJECTIVE: To develop approaches to the development and characterization of advanced ceramic and carbon matrix composites, advanced intermetallic materials and composites for advanced systems.

DESCRIPTION: New approaches to the development and characterization of advanced ceramic and carbon matrix composites, advanced intermetallic materials and composites, are needed for potential Air Force applications in space structures, advanced transatomospheric flight vehicles, and advanced gas turbine engines. New, unique high temperature matrix/reinforcement materials, configurations and oxidation protection systems must be developed and evaluations conducted to determine matrix/reinforcement interactions during manufacture and during application of the composites. Test systems must be developed and applied for use with small samples to determine mechanical and physical behavior, such as failure modes, crack and void growth, oxidation, stress strain and cyclic stress-strain of behavior as a function of temperature and loading histories. Modeling mechanical and physical behavior in terms of composite constituent materials must be implemented and applied to prediction of mechanical behavior, failure characteristics, and response to environmental exposure of structural concepts for potential application in future advanced system designs.

AF87-106. TITLE: Advanced Technology Materials for Electromagnetic Applications

OBJECTIVE: To develop new high performance materials for electromagnetic applications.

DESCRIPTION: The Air Force is interested in developing new high performance materials for electromagnetic applications such as advanced printed wiring boards and radomes. Specific materials of interest include:

a. Low electrical loss fibers. These fibers should have mechanical properties approaching current state-of-the-art graphite (AS-4) with the permittivity of astroquartz (megahertz to gigahertz range) at temperatures of at least 450°F and preferably to 2500°F.

b. High permeability magnetic materials. These soft magnetic materials should have low and high permeability properties in the megahertz to gigahertz frequency range and a tight hysteresis loop. The materials developed should be lightweight and possess magnetic properties comparable to current iron and cobalt systems at temperatures of 350°F and approaching 3000°F.

AF87-107. TITLE: Semantic Data Base

OBJECTIVE: To develop a data management technology capable of controlling and communicating data between several manufacturing processes.

DESCRIPTION: Computer Integrated Manufacturing (CIM) data management at the present time and in the foreseeable future can be characterized as collections of heterogeneous, generally incompatible, special purpose computer systems. Generally, automatic data manufacturing systems and devices on the factory floor have their own data management schemes and protocols; these data management systems reflect manufacturer application, age of development, and performance requirements of the specific task. Interfaces to the user and other data management systems is typically neglected in the development of these databases. In order to control and communicate data between several manufacturing processes it is necessary to develop a data management technology capable of:

Robust input and output
Data conversion/query translation
Automatic updating and integrity checking

This database not only stores the data efficiently for the application but acquires, interprets, converts, modifies, compiles, organizes, checks, translates and communicates data.

The development of this semantic database technology will process the input semantically rather than syntactically. It is suggested that this program address the development of a semantic database which will use relational, object-oriented paradigms to model the manufacturing data. This database will have the capability to dynamically and autonomously develop or reorganize its own data structure without the syntactical bottleneck of contemporary databases.

AF87-108. TITLE: Expert System Development Tool for Manufacturing Application

OBJECTIVE: The development of production oriented manufacturing expert systems.

DESCRIPTION: An integral tool for the successful implementation of unified life cycle engineering is the development of production oriented manufacturing expert systems. The development of these expert systems requires a methodology for knowledge elicited from the particular manufacturing expert and then should be organized into a format that is easily accessed and manipulated by the user. The knowledge that is used for the expert system is commonly known as the knowledge base. Subsequently the prototype knowledge base is exercised to extensively test the knowledge for its necessity, sufficiency, completeness, and consistency with respect to the manufacturing application. Case histories are built up which reflect the growth of the knowledge base and the ability of the expert system to address increasingly difficult problems. In applications such as manufacturing, individual knowledge bases are then combined into knowledge networks which are further

refined to address problems of broader scope. To transition the test system to a real-time, production system the expert system program is tailored for efficiency by eliminating many of the utility programs necessary during experimental development and often translated into a more efficient computer language. The use of expert systems in manufacturing will require automating and compressing this knowledge engineering process. It is suggested that the use of personal construct theory to develop an expert system tool would aid the knowledge engineering process. The expert system development tool would operate by suggesting rules as the knowledge engineering process is ongoing. The development of this tool should significantly automate the development and integration of manufacturing expert systems.

AF87-109. TITLE: <u>Strain Measurement Techniques for Testing High Temperature Structures</u>

OBJECTIVE: To develop procedures for measuring strains in structures subjected to temperatures up to 4000°F.

DESCRIPTION: Current strain measurement techniques are limited to temperatures below 1000°F. As a result, strains in structures subjected to temperatures up to 4000°F cannot be experimentally determined with any degree of accuracy. The objective of this effort is to develop procedures for measuring strains in structures subjected to temperatures up to 4000°F. The suggested approach is to develop optical strain measurement procedures for use at very high temperatures.

AF87-110. TITLE: <u>Automated Crack Measurement Techniques for Fatigue Testing at Elevated Temperatures</u>

OBJECTIVE: To develop an automated system to measure and record crack length and load cycle data from laboratory test specimens.

DESCRIPTION: Visual observation of the surface crack tip as it grows is very costly in terms of manpower and time. This problem is further complicated in elevated temperature by the presence of furnaces or heat lamp assemblies which make visual observations of the crack tip difficult. The material property changes due to temperature also make traditional remote methods (e.g. compliance measurement, electrical resistance) difficult to calibrate and apply. The purpose of this program is to develop an automated system to measure and record crack length and load cycle data from laboratory test specimens (center-cracked and edge-cracked panels, coupons containing cracked holes and notches, compact tension specimens, etc.) The system should be capable of measuring surface crack lengths from 2mm to 80mm in length with a precision of 0.025mm in a temperature field up to 2000°F and accuracy comparable to visual observation of the crack tip at room temperature.

AF87-111. TITLE: <u>Finite-Element Models for the Supportability of United States Air Force (USAF) Aircraft Structures</u>

OBJECTIVE: To establish the feasibility of a USAF-wide data base of finite-element models for the supportability of the structures of USAF aircraft.

DESCRIPTION: The purpose of this program is to establish the feasibility of a USAF-wide data base of finite-element models for the supportability of the structures of USAF aircraft. Structural and dynamic analysts and designers operate on the structures of USAF aircraft at many different sites (e.g. Wright-Patterson Air Force Base (AFB) Laboratories, Wright-Patterson AFB Aeronautical Systems Division, Eglin AFB Laboratories, several Air Logistics Centers and several Air Force System Command Test Centers) and for many different purposes (e.g. ground loads, flight loads, preliminary design, stress analysis, vibrations, acoustics, fatigue, test planning and certification of structural integrity). All of these analyses require finite-element models of the aircraft structures. Usually each activity obtains or develops its own finite-element model, at the level of detail and sophistication that satisfies its specific mission.

The objective of the Phase I effort is to examine in detail the development and use of finite-element models of the structures of USAF aircraft and determine if it is feasible to organize a centralized function to obtain, develop, modify, evaluate, certify and apply those models in an efficient way throughout the USAF. Key features will be the development of methods to transfer data between models of varying detail, using a master model as a primary reference. The contractor shall also develop estimates of the cost of the currently dispersed procedures and the potential tangible benefits of developing the centralized system. If the Phase I effort shows the feasibility, subsequent SBIR Phases could demonstrate the program for one or more USAF fighter aircraft, paving the way for subsequent adoption throughout the USAF structures community.

AF87-112. TITLE: <u>Fatigue Testing Techniques for High Temperature Structures</u>

OBJECTIVE: Develop techniques for performing crack growth tests under combined thermal and mechanical loading.

DESCRIPTION: The current emphasis in structural integrity analyses is shifting toward high temperature structures for hypervelocity vehicles. In order to provide verification capability for these new analysis methods as well as demonstration of compliance with United States Air Force requirements for actual structures, techniques for performing crack growth tests under combined thermal and mechanical loading must be developed. Current technology can provide accelerated testing of loads and account for frequency effects. Similarly, temperature effects are accelerated using equivalent exposure times as calculated by Arrhenius' Law. The interactions between load and temperature effects have only been treated in real time.

This effort shall develop techniques for programming temperature profiles to combine with flight-by-flight load histories and to develop algorithms for calculating equivalent damage combined load/temperature histories which will permit accelerated testing with no loss in crack growth behavior simulation.

AF87-113. TITLE: Scaling of Large Space Structure Joints

OBJECTIVE: To develop accurate prediction or measurement techniques for fundamental system dynamics of future space systems.

DESCRIPTION: Air Force sponsored studies in recent years have identified a variety of future space system concepts which will require large deployable or erectable assemblies. A key requirement for all of these systems is the accurate prediction or measurement of the fundamental system dynamics. Problems of size, presence of gravity, and adequate suspension systems complicate the preflight testing of such structures. If sub-scale models could be used to accurately predict full scale system behavior, significant benefits could result (assuming gravity and suspension system interference can be adequately overcome or allowed for) - such as reduced testing facility requirements, lower testing costs, and greater flexibility to evaluate variations in system design. Since large space structures are literally joint dominated structures, an investigation and understanding of joint scaling is mandatory for such an approach. The initial Phase I program will explore joint characteristics and seek to develop scaling relationships and guidelines using simple, easily fabricated dynamic systems. A follow-on Phase II program could apply the relationships developed to more complex, realistic, large space structure examples.

AF87-114. TITLE: Run Flat/Low Vulnerability Aircraft Tire

OBJECTIVE: To develop designs and approaches for self repairing, improved puncture/pressure loss resistant, or run flat capability for aircraft tires.

DESCRIPTION: During wartime, emergency or training operation, aircraft are either required to operate over airfield surfaces having foreign objects on them or operation on the airfield must await foreign object removal. In many instances, the urgency of the mission will demand operation on the debris covered surface. It has been established that severe tire damage can result from operation over these debris which causes failure or requires tire replacement. Innovative designs and approaches for self repairing, improved puncture/pressure loss resistant, or run flat capability for aircraft tires are solicited. The innovative method taken must not degrade tire durability or performance during normal takeoff, landing, and taxi operations. External volume penalties are unacceptable. Additional weight, complexity, and installation/removal time must be minimal. The goal is to provide a back-up load carrying capability suitable for at least one takeoff and landing with little loss of pneumatic characteristics once the tire casing has been violated.

AF87-115. TITLE: Cargo Aircraft Rapid Loading/Unloading

OBJECTIVE: To develop methods to rapidly load up and discharge cargo and troops from tactical military transport aircraft.

DESCRIPTION: Advanced technology application concepts are sought to implement a capability to rapidly load up and discharge cargo and troops from tactical

military transport aircraft capable of landing on unprepared terrain behind forward battle front areas. Concepts should facilitate one or more of the following jobs:

a. Airdrop and recovery of personnel and cargo with emphasis on low linear ground dispersion.

b. Ground loading and unloading of material and personnel with emphasis on rapid turnaround concepts that support minimum contamination of cargo compartment by chemical warfare agents.

Concepts should consider materials handling equipment and design of cargo compartment, automation and robotics approaches.

AF87-116. TITLE: Integrated Test System-Aircraft Ground Operation

OBJECTIVE: To develop methodology for the conduct of Flight Dynamics Laboratory Landing Gear Development Facility (LGDF) landing gear tests as an integrated part of piloted Large Amplitude Multimode Aerospace Research Simulator (LAMARS) aircraft simulations.

DESCRIPTION: Future high performance aircraft will require landing gear which must perform in a much more severe operating environment than current aircraft. To provide suitable landing gear and reduce program risks, a much higher level of confidence must be achieved for landing gear laboratory test results. Currently, landing gear and their components are tested under simulated ground operating conditions in the LGDF. However, the degree of simulation is limited by lack of ability to adequately consider pilot inputs and other aircraft interactions. Located near the LGDF is FDL's Large Amplitude Multimode Aerospace Research Simulator (LAMARS) Facility, in which very reliable piloted aircraft simulations are conducted. A much higher level of confidence could be established for landing gear tests if they and piloted LAMARS tests could be integrated to produce an optimum simulation of ground operating conditions during landing gear tests.

The feasibility of and scope of work needs to be established for conducting LGDF landing gear tests as an integrated part of piloted LAMARS aircraft simulations. The Phase I effort includes determining modifications needed to various LGDF landing gear test machines and the LAMARS facility, and how data should be transferred between the LGDF and LAMARS facilities. The anticipated improvement to the confidence level for landing gear test data will also be projected by the contractor.

AF87-117. TITLE: Fighter Cockpit Ingress in Chemical Warfare Environment

OBJECTIVE: To develop technology procedures and equipment to allow pilot ingress into aircraft cockpits while excluding the chemical agents and obviating the need for the protective garment.

DESCRIPTION: Measures for protecting the crew and insuring air purity within enclosed fighter cockpits during aircraft operations in a chemical warfare environment are under development. Because of the risk of introducing

chemical contaminants from the atmosphere or carried on clothing during cockpit ingress, an encumbering protective garment is required in addition to collective onboard protection. A highly desirable goal is to permit crew functioning within a shirt sleeve environment. Accordingly, provisions employing applications of technology and appropriate procedures are sought to allow pilot ingress into fighter aircraft cockpits while excluding the chemical agents and obviating the need for the protective garment. Concepts and primitive demonstrations are solicited which should consider palatable modifications to aircraft and canopies, and other equipment and vehicles common to airports and airfields and, if necessary, new equipment concepts. Concepts should be compatible with the scenario, aircraft and personnel status starting from an alert status and proceeding rapidly to aircraft takeoff following a chemical airbase attack.

AF87-118. TITLE: Flow Field Separation Approximations for Hypersonic Aerodynamics

OBJECTIVE: To solve problems associated with complex flow fields, resulting in interference phenomena which produce flow separation.

DESCRIPTION: The development of advanced technology for hypersonic aeromechanics includes the solution of problems associated with complex flow fields, resulting in interference phenomena which often produce flow separation. Flow separation is a common occurrence on maneuvering aerospace vehicles. Analysis is pursued in two ways: a rigorous solution of the Navier-Stokes equations in a time dependent system for highly accurate point design data; and an approximate semi-empirical approach sufficiently accurate for preliminary evaluations. The purpose of this Phase I effort will be the development of more accurate approximations. The major types of flow separation to be addressed are the lee side areas during maneuvers, areas ahead of windward deflected controls, and regions of shock impingement for adjacent surfaces. The method will use boundary layer edge conditions and integral boundary layer properties as inputs. The outputs will be the dimensions of the separated region, the surface properties in the separated region, and the flow field properties from the surface to the inviscid edge of the region. Semi-empirical relations will be developed using experimental measurements and exact flow field computations as data. The result will be compiled in a report presenting graphical solutions and algebraic relations for preliminary design approximations.

AF87-119. TITLE: Nonintrusive Hypersonic Facility Diagnostics

OBJECTIVE: Develop a system which will provide accurate, off body velocity measurements in hypersonic flow facilities, and provide a suitable flow visualization capability.

DESCRIPTION: Current reemphasis on hypersonic flow measurements, as necessary for the design and development of hypersonic flight vehicles, has focused attention on the need for modernizing and improving hypersonic flow diagnostics systems. With techniques being developed to improve the simulation quality, the need arises for new measurement systems. Current,

nonintrusive diagnostics in the hypersonic facilities include schlieren, interferometry, infrared scanning and limited Laser Doppler Velocimetry (LDV). LDV is limited by the high Doppler frequencies associated with very high velocities and small test volumes needed for high resolution measurements. Additionally, the seeding requirement for LDV in low density flows must be carefully considered where the mean free path is significant in relation to particle diameter (i.e., Knudsen number $\gg 1$). The technique and type of seeding must also be examined in the development of advanced flow visualization to derive maximum benefit from this approach. What is needed is a system/technique which, at a minimum, will provide accurate, off body velocity measurements in hypersonic flow facilities, at least to Mach 14, and also provide (not necessarily concurrently) a suitable flow visualization capability after minor reconfiguration. Accuracies for the velocity system should be comparable to LDV measurement currently being made at the lower Mach numbers.

AF87-120. TITLE: Turbulence Measurements in Hypersonic Flow

OBJECTIVE: To develop methods for obtaining turbulence measurements in hypersonic flow.

DESCRIPTION: The Flight Dynamics Laboratory (FDL) is interested in obtaining turbulence measurements in hypersonic flow. The objective of this Phase I effort is to develop the theory, approaches, and techniques necessary to measure turbulence quantities that currently cannot be measured. Hot wire anemometry and laser doppler velocimetry should be used in developing the data acquisition process. The diagnostic systems must be compatible with FDL's High Reynolds Number Mach 6 wind tunnel and 20 inch Mach 12-14 wind tunnel facilities. The approach used must be capable of calculating Reynolds stresses and terms which involve density fluctuations. For example:

$$(\rho u)'v' = \bar{\rho}u'v' + u'\rho'v' + \rho'u'v'$$

For low Mach numbers, the term $\rho'u'v'$ is usually neglected, but at high Mach number it is not negligible and should be measured. The goal of this effort is to develop an experimental capability to perform the needed measurements. A Phase II effort could experimentally verify the Phase I methods in FDL's wind tunnel facilities.

AF87-121. TITLE: Configuration Analysis for Dynamic Maneuver Performance

OBJECTIVE: To develop conceptual design and analysis tools which allow evaluation of novel or unique aeromechanic technologies which yield excellent aircraft transient performance.

DESCRIPTION: The intense battlefield environments of future conflicts will require advanced Air Force fighter aircraft to possess superior Vertical/Short Takeoff and Landing capability and maneuver agility. To achieve both of these qualities, conceptual design and analysis tools must be developed which allow evaluation of novel or unique aeromechanic technologies which yield excellent aircraft transient performance. Current analysis of aircraft dynamic motions involves solving the equations of motion in terms of static and first order

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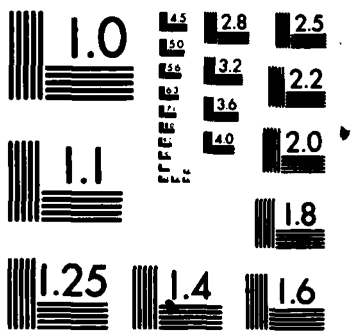
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dynamic stability derivatives. This analysis is extremely cumbersome and of limited accuracy due to the numerous linearizing assumptions involved and the extreme difficulty in obtaining accurate dynamic stability derivatives. The objective of this Phase I effort is to utilize advanced computational techniques to continuously calculate the time dependent forces and moments on a complete aircraft configuration, integrate these forces and moments, and obtain the resulting aircraft trajectory. A modularized aircraft performance computer algorithm shall be developed which incorporates state-of-the-art dependent aerodynamic prediction routines with an accurate numerical performance integration to predict aircraft motions resulting from arbitrary control inputs. The modular aerodynamic analysis routine should be capable of being easily upgraded as computational needs are justified or advances in analytical fluid dynamics occur. The feasibility of this newly developed configuration analysis and performance prediction routine shall be documented with performance comparisons with existing configurations.

AF87-122. TITLE: Digital Database Support for Tactical Situation Displays

OBJECTIVE: To develop digital database support for tactical situation displays.

DESCRIPTION: The advancements in digital storage and graphics processors, combined with the expansive Digital Landmass System (DLMS) database from the Defense Mapping Agency (DMA), makes possible the development of plan view and pilot-perspective tactical situation displays. Such data-driven displays have application in simulators, mission planning stations, and airborne crew stations. The data would also be used for system integration of navigation, flight path control, fire control, and threat avoidance functions. A logistical link is required between the available DMA data and the target display processors. The DMA data would be augmented with tactical data from operation orders, intelligence, weather forecasts, etc., in the ground environment. In airborne applications, the above data would be supplemented with external data link and onboard sensors.

Several studies have been performed that have defined the data required to fly a tactical mission. Additional research is needed to define the logistical support for creation and maintenance of a computerized data base and for pilot interaction with the data base to compile the mission/flight plan. The Phase I effort should begin with identification of available technology and data sources; proceed to the definition of an operational concept to collect, merge, process, distribute and modify/update the data base; and finally to propose the hardware, software and data architecture for such a system. This conceptual design should link the flow of DMA and other data into an advanced squadron-level mission planning station. The mission planning station should provide for integration and preview of essential data elements and data output for transfer to the aircraft display processors. Configuration control of both ground and flight software should be included in the conceptual design.

AF87-123. TITLE: Abductive and Inductive Reasoning in Maintenance Diagnostic Systems

OBJECTIVE: To determine whether the capabilities of abductive reasoning combined with inductively-synthesized hypothesis testing, will aid in the development of flight control system maintenance diagnostic software.

DESCRIPTION: Research is needed to determine whether the capabilities of abductive reasoning combined with inductively-synthesized hypothesis testing will aid in the development of flight control system maintenance diagnostic software. Currently, maintenance diagnostics software for troubleshooting complex equipment such as aircraft flight control systems uses logical and statistical failure data. The limitation of this approach for new flight control systems stems from its dependence on statistical data. Abductive reasoning would improve the performance of the decision making process for new maintenance diagnostic systems. The abductive identification selects a small number of plausible hypotheses, and rank-orders them using a judgment based on their probability of occurrence. Then instead of automatically choosing the hypothesis having highest probability, the several most likely hypotheses are tested via an inductive reasoning process which is based on the designer's understanding of the system behavior. The diagnosis would proceed to the most likely fault. For this fault, a test is made using the appropriate system observable(s). The next most probable fault is then tested. The use of abductive reasoning combined with inductive reasoning will significantly benefit the development of future flight control maintenance diagnostic systems for advanced aerospace vehicles.

AF87-124. TITLE: Long Life, Multi-Megawatt Space Power Systems

OBJECTIVE: To develop improved long life, survivable multi-megawatt space power systems, while reducing weight and cost, and increasing life to a minimum of 5 years in low orbits and 10 years for high orbits.

DESCRIPTION: Near-term power requirements of military satellite power systems are 5 to 50 KW. Future power requirements extend to the multi-megawatt range. Survivability and long-life are required for all future missions. Technology needed to meet these requirements includes system and component technology in the 200 to 300 VDC range. Technology is needed to improve system performance, reduce weight and cost, and increase life to a minimum of 5 years in low orbits and 10 years for high orbits. The following developments are needed:

a. Research and development of high power solar cell array technology is needed to enhance the survivability of the array and improve end-of-life efficiency and performance. Techniques are sought to increase survivability at temperatures up to 600°C and provide protection from hostile environments. Techniques are needed to provide autonomous operation of the solar array as part of a power system on a spacecraft.

b. Fully packaged rechargeable satellite batteries are needed with the following characteristics: 1) a usable specific energy of 100 watt-hours per pound under the following conditions: charge-discharge cycle life of up to 15,000 cycles, calendar life of 10 years or more, change times of 5.25 to 22.8

hours, discharge times of .75 to 1.2 hours, and peak power capability of 1 KW per pound and 2) a usable specific energy of 50 watt-hours per pound for 30,000 charge-discharge cycles.

c. Spacecraft power system thermal management research is required in the areas of 1) steady and unsteady 2-phase heat transfer for power electronic cooling in the 300-400K regime; 2) ultralight expandable radiator concepts and other heat rejection, transport and storage techniques; 3) flow stability and heat transfer phenomenology related to zero-gravity 2-phase, unsteady high flux heat transfer processes in cryogenic reactants; and 4) high temperature thermionic devices, high temperature thermal energy storage, and associated heat transfer mechanisms.

AF87-125. TITLE: High Power For Space Applications

OBJECTIVE: To develop high power component technology for space applications.

DESCRIPTION: Development of one or more of the following technologies is needed in the area of high power for space:

a. Lightweight energy storage capacitors with an energy density greater than 500 joules per pound per assembled device, output voltage greater than ten kilovolts, response time less than ten nanoseconds, and lifetimes of greater than 1.0 million pulses per device. Lightweight energy storage inductors with an energy density greater than 1000 joules per pound per assembled device, output voltage greater than 200 volts, response time less than 1.0 microseconds, and an indefinitely long lifetime.

b. Repetitive opening and closing switches for pulse power output of between 10 and 100 kilovolts and 0.1 to 1.0 million amps. Response time must be less than or equal to 100 nanoseconds and lifetime must exceed one million events.

c. High temperature power semiconductor device with a maximum junction temperature of 3000 degrees centigrade, low power dissipation, and the ability to switch 10 amps at 1.5 KW per device.

d. High power, high voltage, high current density pulse conductors that are lightweight, high-strength, and applicable for the space environment. Pure metal conductors must be suitable for use in generator windings and magnets and able to transmit pulsed as well as continuous high power without conductor failure. Intercalated graphite conductors must be lighter weight and higher strength than copper and aluminum. Also, assembled intercalated graphite filaments; must be able to transmit pulsed as well as continuous high power without conductor failure. Superconducting conductors must be able to continuously carry 150 kiloamps per square centimeter at an operating temperature above 7.0 degrees Kelvin without going normal. Dielectric insulation for these conductors must be lightweight, thermally and chemically stable for the space environment and have a voltage withstand of 20 kilovolts per mil of thickness.

AF87-126. TITLE: Batteries For Aircraft And Missile Power

OBJECTIVE: To develop advanced electrochemical power source systems that offer increased life with improvements in energy and/or power density.

DESCRIPTION: Advanced electrochemical power source concepts are sought that offer revolutionary improvements in energy and/or power density. Batteries are needed with the following performance characteristics:

a. Rechargeable batteries that provide a gravimetric energy density of 100 watt-hours/pound, volumetric energy density of 8 watt-hours/cubic inch, power density of 300 watts/pound, 15-year life, 1000 charge/discharge cycles, energy efficiency of at least eighty percent, and a self-discharge rate of 10,000 hours or slower. The size range of interest is from two through five-thousand ampere-hours.

b. Active primary batteries for survival avionics that deliver thirty or more watt-hours/cubic inch and at least 100 watt-hours/pound at the ten-hour discharge rate with pulses at the twenty-minute rate near end of life. The batteries must operate over the temperature range from -65 to +210 degrees Fahrenheit. The size range of interest is from 0.5 to 30 ampere-hours.

c. Active primary batteries for ground and mobile power applications that provide over 400 watt-hours/pound, over 25 watt-hours/cubic inch, 100-hour or slower discharges, and 15-year shelf life.

d. High power density primary reserve batteries for airborne applications that can provide peak power densities of at least, 10,000 watts/pound in a pulsed mode of operation for total active lifetimes of up to 300 seconds with shelf life of 25 years and no degradation. Other parameters of interest are: activation within one second or less by an electrical pulse, airborne environments, operation over the temperature range from -65 to +165 degrees Fahrenheit without any external heat source, gravimetric energy of 50 or more watt-hours/pound, and volumetric energy density of one or more watt-hours/cubic inch.

AF87-127. TITLE: High Power Electrochemical Power Sources For Space

OBJECTIVE: To develop high power long life electrochemical power sources for space applications.

DESCRIPTION: High power and energy density rechargeable and non-rechargeable electrochemical power sources should not produce effluents during storage and/or operation. A calendar lifetime of at least ten years is desired with an active lifetime of 0.3 hours under random intermittent load conditions over the ten year lifetime. Instant on-instant off capability is desired. Peak power density goal is 0.1 lb/kwh including all reactant, case, seal, terminal, connector, structure and auxiliary weights. The power source must not produce any torque, thrust, moments, gyroscopic effects or vibration external to itself.

AF87-128. TITLE: Test Techniques For Very High Mach Number Scramjets

OBJECTIVE: To develop advanced testing methods to extend the test times or to develop improved instrumentation, which can respond rapidly in the high temperature environment of the flow.

DESCRIPTION: Theoretical studies indicate that supersonic combustion ramjets (scramjets) can produce thrust up to Mach 25. Continuous flow or blow down facilities can simulate flow only up to Mach 8. Above that, shock tunnels or similar facilities must by used to obtain experimental data. Test times are of the order of milliseconds. The objectives of this program are to develop advanced testing methods to extend the test times or to develop improved instrumentation which can respond rapidly in the high temperature environment of the flow. Simulation of the total temperature and pressure of the flow with a large-scale model is necessary to understand the combustion phenomena. One particularly desirable measurement that currently cannot be accurately made is the skin friction of the flow on the surface of the model.

AF87-129. TITLE: Advanced Air Separation Concepts

OBJECTIVE: To develop methodologies for in-flight collection of air by hypersonic, suborbital and orbital vehicles for the purpose of separating oxygen and storing it for use as in a rocket.

DESCRIPTION: Promising concepts are sought for in-flight collection of air by hypersonic, suborbital and orbital vehicles for the purpose of separating oxygen and storing it for use as in a rocket. Concepts of oxygen separation/enrichment for use in-flight must place a premium on lightweight, small volume devices/processes capable of very high air handling rates. Methods considered previously have included distillation, cycle oxidation-reduction, and membrane processes. New materials and new processes should be examined for potential application.

AF87-130. TITLE: Prevention of Freezing in Cryogenic Heat Exchangers

OBJECTIVE: To develop techniques by which flow blockage can be minimized in cryogenic heat exchangers.

DESCRIPTION: Atmospheric air when cooled to very low temperatures by heat exchange with cryogenic fluids will deposit water and CO_2 on the heat transfer surfaces, reducing heat transfer efficiency and causing blockage of airflow passages. Techniques are sought by which flow blockage can be minimized. The water and CO_2 may be actively removed or accommodated by features of the design. Active removal means should avoid great complexity as well as large weight and volume. Means of accommodating ice and CO_2 should also be light and as small as possible.

AF87-131. TITLE: Combined Cycle Propulsion Technology

OBJECTIVE: To develop concepts and approaches for combined cycle propulsion systems which involve the elements of ramjets, scramjets, rockets, turbojets, turbofans, and ejectors in various combinations.

DESCRIPTION: New and novel concepts and approaches are sought for combined cycle propulsion systems which involve the elements of ramjets, scramjets, rockets, turbojets, turbofans, and ejectors in various combinations. Such propulsion systems would be capable of operating over a wide range of flight Mach numbers from 0 to 8 or above. Both manned and unmanned vehicles are involved. The aim of combined cycle propulsion systems is to maximize the overall system efficiency by exploiting the attributes of the various elements in their respective best operating speed regimes. In addition to maximum efficiency, emphasis is also placed on low weight, volume, and cost.

AF87-132. TITLE: Advanced Fuels For High Mach Aircraft

OBJECTIVE: Devise a separation scheme which can be easily performed that segregates typical aviation fuel to the extent that various classes of compounds can easily be determined.

DESCRIPTION: The complexity of aeropropulsion fuels presents strong challenges to current instrumental/analysis techniques. Usually, techniques involve costly instruments, impractical chemical preparation, and provide inaccurate data. Given the complex nature of most fuels, devise a separation scheme which can be easily performed that segregates typical aviation fuel to the extent that the following classes of compounds can easily be determined: Paraffins (both normal and branched), alkylbenzenes, indans and tetralins, mono-dicycloparaffins and tricycloparaffins, indanes and dihydronaphthalenes, naphthalenes, flourences, anthracenes, acenaphthylenes, and olefins. Demonstrate using analytical chemical techniques that the scheme is more accurate and quantitative than current methods.

AF87-133. TITLE: Chemical Analyses of Advanced Fuels

OBJECTIVE: To develop fuels to power vehicles at speeds above Mach 10 which provide adequate heat sink, high heating values, good combustion characteristics, long-term stability and the necessary potential availability.

DESCRIPTION: Conventional liquid hydrocarbon distillate fuels cannot provide sufficient heat sink capacity to cool other aircraft and engine system components and tend to form deposits within critical portions of the engine fuel system when used at speeds above the Mach two to three range. Cryogenic fuels, such as liquid hydrogen, have excellent heat sink capacities but have undesirable low volumetric energy characteristics and storage and handling problems. Special liquid hydrocarbons which undergo catalyzed dehydrogenation reactions and vaporization to provide additional heat sink capacity have also been studied. New fuels and fuel concepts are required to power vehicles at speeds above Mach ten. New, innovative fuels are needed to provide adequate heat sink, high heating values, good combustion characteristics, long-term

stability and the necessary potential availability. New approaches to the synthesis and production of improved fuels through the application of selected combinations of chemicalcatalytic reactions and catalyst systems are required.

AF87-134. TITLE: Fuel Combustion Technology

OBJECTIVE: To demonstrate significant advances in combustion technology.

DESCRIPTION: Renewed interest in hypersonic flight and continued emphasis on improving the performance of conventional aircraft require significant advances in fuel combustion technology. Specific topics of interest include: (1) combustion enhancement concepts for use with conventional and advanced fuels in subsonic and supersonic combustors wherein the ignitability of laminar flame speed of the fuel is inadequate under some flight conditions; (2) new fuel/air mixing concepts for potential use in subsonic and supersonic combustors to increase combustion efficiency, reduce pressure losses and permit the development of smaller, lighter combustors; (3) new or improved fuel combustion, mathematical models that accurately calculate fuel/air mixing in the presence of large-scale turbulent structures, include simplified but accurate fuel pyrolysis and oxidation kinetics and include two-phase flow capabilities for handling liquid fuel injection and atomization; and (4) new combustion diagnostics that can measure temperatures, pressures, species concentrations and other parameters non-intrusively and with data rates exceeding 10,000/seconds.

AF87-135. TITLE: Novel Methods for Evaluation of Solid and Liquid Lubricants

OBJECTIVE: To develop methodologies/processes to efficiently and accurately assess the thermal, oxidative and tribological capabilities of candidate lubricant materials/formulations which may be available in very small quantities only.

DESCRIPTION: Novel methods of evaluation are required for advanced fluid and solid lubricants for potential high performance turbine engine applications. Advanced fluid operational temperatures in the range of 315°C or higher and solid lubricants at 540°C to 1000°C or higher are projected. The need is to efficiently and accurately assess the thermal, oxidative and tribological capabilities of candidate materials/formulations which may be available in very small quantities only.

AF87-136. TITLE: Turbine Engine Bearing Concepts

OBJECTIVE: To design rolling element bearings for advanced turbine engines with higher rotor speeds.

DESCRIPTION: In order to meet thrust-to-weight ratio goals of advanced engines, it is predicted that rotor speeds will need to increase in the order of twenty-five percent over current state-of-the-art production military engines. Innovative approaches are needed for the design of rolling element bearings to obtain the life of current engine systems while operating at these higher speeds. Previous approaches have included: Series-Hybrid

Thrust Bearings, Dual Diameter Roller Bearings, hollow rolling elements and high-speed tapered roller bearings. Additional innovative concepts should be conceived and analyzed in this research effort for their application to, and suitability for, turbine engine mainshaft support.

AF87-137. TITLE: Angular Weaving for Turbine Engine Composite Components

OBJECTIVE: To reduce the fabrication costs and inherent flaws associated with components made from composite reinforced materials using angle ply hand layups and woven filament mats.

DESCRIPTION: Fiber reinforced composite materials offer design alternatives which will enable the designer of gas turbine engine components the ability to develop lightweight, low cost, high performance engine components. The purpose of this effort is to reduce the fabrication costs and inherent flaws associated with components made from composite reinforced materials using angle ply hand layups and woven filament mats. Critical to efforts such as utilizing metal matrix composite materials in a gas turbine engine low-pressure spool shaft application, are uniformly spaced woven filament mats at fiber orientations in the warp direction ranging from zero to forty-five degrees depending on the structural requirements of the shaft. The desired fiber weaving effort shall address the costs of the angle weaving process and will compare this to current fiber weaving methods and layup operations. An assessment will be made to determine if the angular weaving process will provide a reduction in fabrication costs. It will be determined if an increased capability to fabricate components from composite materials is obtained and whether any limitations are imposed by the fiber on the weaving process.

AF87-138. TITLE: Turbine Engine Test Instrumentation Techniques

OBJECTIVE: To develop new sensors/systems for the accurate determination of the strains and temperatures under which engine components must operate.

DESCRIPTION: An area of ever increasing concern in the turbine engine community is the accurate determination of the strains and temperatures under which engine components must operate. Advanced engine test programs are limited by the problems associated with current structural instrumentation capabilities. The state-of-the-art of structural instrumentation has many shortcomings in both the strain gage and thermocouple areas. Current turbine engine tests are particularly impaired by the fact that present instrumentation is commonly temperature limited, short lived, inaccurate, and either protrudes into the gas flow stream or requires trenching the structural component in order to embed the sensor.

For these reasons, new sensors/systems capable of surviving the harsh environments of a turbine engine while providing accurate strain and/or metal temperature data are required. Candidate sensors/systems should be capable of withstanding the temperatures and strains typical of turbine engines for extended periods while detecting strain to within plus or minus 5 percent and temperature to within plus or minus 1 percent. Additionally, proposed techniques should have minimal influence on blade parameters and gas flow path.

AF87-139. TITLE: Compression System Design Methodology

OBJECTIVE: To develop enhanced and advanced compression system and secondary flow design methodologies.

DESCRIPTION: This is to be achieved by numerous theoretical and experimental efforts including such work as computer modelling, cascade testing, bench rig tests, etc., all adequately documented as to be acceptable to the technical community. A major trend in compression system hardware is the increased utilization of low aspect ratio blading, blisks, and three-dimensional design methodology. The primary and secondary flow system design capability which is currently two dimensional must be extended fully into three dimensions to adequately exploit these trends. Adequate documentation of this work and its influence on turbomachinery is needed as in a comprehensive background document on turbomachinery. Areas of prime technical importance include blade/vane sweep, shock/boundary layer interaction, secondary flow design (including such areas as counter-rotation, trenching, labyrinth seals, and disc pumping), time unsteady features of the turbomachinery gas path, and secondary flow systems.

AF87-140. TITLE: On-Wafer Testing of MMICs

OBJECTIVE: To improve screening and testing methods to better characterize the circuits and to eliminate chips as early in the fabrication sequence as possible to reduce overall chip cost.

DESCRIPTION: The development of gallium arsenide (GaAs) monolithic microwave integrated circuits (MMICs) has progressed rapidly during the last five years. Laboratory demonstrations of single and multiple circuit functions in the same chip have been very impressive. A number of companies have built pilot-line production facilities or make use of foundry services to produce small to medium quantities of MMICs. Problems of variations in DC and RF performance and low yield fabrication processes plague MMICs. Improved screening and testing methods are needed to better characterize the circuits and to eliminate chips as early in the fabrication sequence as possible to reduce overall chip cost. The objective of the subject program is to develop on-wafer testing equipment, methods and procedures for GaAs Field Effect Transistor (FET) based MMICs that are fabricated on 3" diameter semi-insulating substrates. Such equipment and techniques will be capable of performing automatic or manual DC and RF probing of discrete and MMICs on the wafer. On-wafer calibration will be part of the measurement sequence. DC parameters such as saturation current, pinchoff voltage, transconductance, contact resistance, and fat FET will be measured; RF parameters such as S-parameters, return loss, and gain will be measured in conjunction with an automatic vector network analyzer as a function of frequency in the 0.1 to 26 GHz frequency range. The contractor shall explore both contacting and noncontacting probing of MMIC wafers. Emphasis shall be placed on developing probing equipment and techniques that are directly applicable to high volume, high rate production of GaAs MMICs.

AF87-141. TITLE: Processor for Artificial Intelligence/Ada Applications

OBJECTIVE: To investigate and develop a 32-bit militarized processing module with an instruction set architecture that will efficiently perform

both AI and Ada-type processing and compatibility with applicable backpanel bus standards.

DESCRIPTION: The Avionics Laboratory is presently developing 16-bit Very High Speed Integrated Circuit (VHSIC) data processor modules for both embedded and standalone applications and VHSIC common signal processor modules which are compatible with the advanced system avionics architecture currently being developed. A standard backpanel bus system to interconnect these modules is also being developed in order to achieve module-level interoperability and to support the two-level maintenance concept. These processing elements are being developed based upon a conventional (Von-Neuman) computer architecture with JOVIAL as the high order language (HOL). Several new items have surfaced which, if incorporated into the design, would significantly enhance the capability of the system. Artificial intelligence (AI) is an emerging technology which involves rule-based processing versus conventional "number crunching." Also, Ada has been adopted as the Air Force standard HOL for avionics data processing and will impose its own set of unique processor architecture considerations. These factors, coupled with the improved performance offered by 32-bit processors, present the opportunity to investigate advanced 32-bit processor instruction set architectures which efficiently execute either AI or Ada based software in a single processing element. Such a processor represents the next step in the development of the avionics architecture.

This effort will investigate the feasibility of a 32-bit militarized processing module with an instruction set architecture that will efficiently perform both AI and Ada type processing and compatibility with applicable backpanel bus standards to support integration into future systems. Available 32-bit processors will be evaluated with respect to unique Ada and AI processing requirements. This research will provide the basis for a common module specification for an AI/Ada processor element and its associated bus system as well as a common 32-bit instruction set for processor operation.

AF87-142. TITLE: Biomass Adaptive Network

OBJECTIVE: To demonstrate an ability to train a biomass culture, thus simulating motor output for the network with feedback.

DESCRIPTION: This research will involve coupling organic cells with adaptive networks (e.g. Hopfield nets) which will interact with and control the organic activity. Specifically cultured neuronal cells will be surgically customized to reside on a dense array of microelectrodes photoetched onto a glass substrate. The objective will be to demonstrate an ability to train the culture, thus simulating a motor output for the network with feedback. The culture will be connected via a cable to an adaptive network which will interact with and provide stimulus signals to the neuronal array. Specific aims for this research include paralleled high speed data acquisition and correlation among channels, development of statistical procedures to analyze cellular electrical activity patterns, computer storage of cell morphological data, network monitoring and control of biological activity, and identification of biological pattern generation circuits.
This project will substantially accelerate investigations of biological

networks and begin to disclose basic principles of neuronal network architecture and function. Advances in understanding these functions can lead to true machine intelligence, reliable autonomous vehicles, adaptable control circuits which learn from experience, natural language understanding and gracefully reconfigurable command and control structures. The network is the simplest operational level for the study of signal processing and storage, the phenomena which form the basis of memory, learning and behavior. Progress in this area could have a profound effect on future computer design and programming.

AF87-143. TITLE: Design Automation Knowledge Representation

OBJECTIVE: Formal representation of design knowledge for embedded electronic systems.

DESCRIPTION: The design of complex embedded military electronic systems requires design automation systems with sophisticated internal representations of symbolic and numeric design knowledge. Ideally, design fact domains and design rule domains should be formalized, complete, orthogonal, consistent, and validated; they should generate successful designs efficiently, or quickly determine that none exist. They should describe logical and physical design components, and analog and digital ones; they should describe the design rules used to implement tools and metatools; they should support query/answer transactions and tutorial design explanations. Good design knowledge representation can make the difference between quickly synthesizing a low-cost high-performance design, and not being able to find one at all (even though it exists). To implement good internal design knowledge representations, creative research is required in all areas of design knowledge representation for embedded electronic systems. The upper bound of this research is the formal representation of system requirements for the many current perceptions of "system;" the lower bound is formal expression of knowledge for design "primitives," the lowest-level indivisible design components. This research includes knowledge representation for Mil Specs and Mil Standards; it includes electrical and physical design, as well as electronic design. Proposals should focus on a well-defined internal design knowledge domain relevant to embedded military electronic systems. Efficient hardware implementations of available design knowledge models are not excluded. This research will eventually result in prototype demonstration of design knowledge representations on a workstation, mainframe, or other appropriate design automation computer system.

AF87-144. TITLE: Computer-Aided Design of MMICs

OBJECTIVE: Develop circuit design and layout procedures that are applicable to the high volume, high rate MMIC production environment.

DESCRIPTION: Historically gallium arsenide (GaAs) monolithic microwave integrated circuits (MMICs) have been developed based upon hybrid microwave integrated circuit concepts, fabrication techniques, and design procedures. This approach suffers from large variations in MMIC DC and RF performance, low fabrication yields and high chip cost. MMICs possess unique processing and circuit design opportunities that physically and electrically do not exist for

hybrid ICs. The objective of this program is to exploit these opportunities to develop MMICs that perform to specification and are affordable. The contractor shall develop computer-aided design techniques that permit the adjustment of circuit topologies and configurations, based upon in process test results, to enhance the final circuit performance and yield. Emphasis shall be placed on circuit design and layout procedures that are applicable to the high volume, high rate MMIC production environment. Concepts such as reconfigurable MMIC analog arrays shall be investigated for such components as low noise and power amplifiers, phase shifters, and transmit/receive switches operating in the 1-20 GHz frequency range. Materials, computer-aided design, fabrication, assembly and testing factors will be considered as the design approaches are investigated and refined.

AF87-145. TITLE: Communication Requirements for The Hypervelocity Vehicle

OBJECTIVE: To define and develop the communications requirements for the Hypervelocity Vehicle.

DESCRIPTION: The Hypervelocity Vehicle will be a vehicle that can operate as an airplane at hypersonic velocities (4000 to 8000 miles per hour) in the upper atmosphere or as a space launch vehicle capable of accelerating directly into orbit.

This effort shall define the communications requirements for the Hypervelocity Vehicle given certain defined mission scenarios for the vehicle. Driving technical problems are imposed by the mission, vehicle dynamics and the environment. Some of the primary communications technology areas of concerns are:

a. High data rate jam resistant communications
b. Laser communications
c. Integrated Multifunction Antennas
d. Doppler effects
e. Low probability of Intercept
f. Communications during blackout on re-entry from space into the earth's atmosphere

AF87-146. TITLE: Electro-Optical Sensors on Hypervelocity Platforms

OBJECTIVE: Quantify problems associated with use of active and passive electro-optical (EO) sensors in the visible and infrared bands from hypervelocity platforms and necessary technology developments specified.

DESCRIPTION: Problems associated with use of active and passive electro-optical (EO) sensors in the visible and infrared bands (.5-1.0 μm, 3-5 μm, 8-12 μm) from hypervelocity platforms need to be quantified and necessary technology developments specified. The range of window temperatures, near window turbulence, and any other near window atmospheric affects need to be specified. Window materials and protection techniques should be discussed. Calculations of potential sensor performance looking through a hot window need to be performed for various background suppression techniques. Methods of handling

near window turbulence should be discussed with consideration given to mechanical methods of reducing turbulence and methods of digitally compensating for turbulence. Adaptive optics methods of compensating for turbulence should be avoided unless simple methods, possibly using phase conjugation effects, can be found. Phase I results should include recommendations for specific developments needed to make future use of EO - systems from hypervelocity platforms practical. A Phase II demonstration of needed technology should also be defined at the conclusion of Phase I.

AF87-147. TITLE: Layered Semiconductor Devices

OBJECTIVE: To develop methods for assessing the viability of layered semiconducter devices.

DESCRIPTION: Semiconductor device structures composed of thin layers separated by atomically sharp interfaces have become the basis of a rapidly expanding technology. The unique physical properties of such ultra-structured material devices have already resulted in significant improvements in performance of a variety of devices and new concepts are constantly being considered. These new structures are necessary for the continued advancement in the state of the art of digital, electro-optical and micro/millimeter wave technology. Areas which must be considered in assessing the viability of such devices include material growth device processing, physics and device performance. There is interest in addressing these areas separately or in concert. Efforts designed to improve the understanding of the unique physical properties of these structures, especially those which address electro-optical and/or high-speed phenomena are of great interest. Computer or mathematical models of transport or crystal growth are needed and novel device concepts verification is strongly encouraged. Development of the processes that are specific to the fabrication of these structures and associated devices such as ways of selectively contacting specific layers, ways of growing complementary structures on the same substrate or ways of achieving high device density will be given consideration. The Gallium Arsenide-Aluminum Gallium Arsenide system is the one that is presently of highest interest but other materials combinations that would enhance some aspects of performance are also considered important.

AF87-148. TITLE: High Speed Random Access Camera

OBJECTIVE: To develop a high speed random access camera (RAC).

DESCRIPTION: The development of optical processors is limited due to devices that require relatively long times to get information into and out of the system. In order to generalize an optical processor to perform more than one function (a step toward an optical computer), the physical hardware of the system usually has to be reconfigured. These two problems can be decreased by the development of a high speed random access camera (RAC). The RAC is an array of detectors that can be randomly addressed electrically or optically by pixel as opposed to reading the entire frame serially. This would result in significant time savings for addressing selected portions of a scene and would be especially useful when combined with prior knowledge of the information in

the system. The RAC could also address different areas of the array for different processor operations which would permit programmable operation through reconfiguration of the optical system interconnects. A silicon based RAC operating in the visible to near-infrared wavelength band with individual pixel access times of 1 microseconds or less is a much needed device for optical processor operation.

AF87-149. Dynamic Holography Cockpit Display

OBJECTIVE: To provide research towards solution to Air Force systems requirements for more effective coupling of operators to advanced systems.

DESCRIPTION: We are seeking solutions to Air Force systems requirements for more effective coupling of operators to advanced systems. One primary concern in these virtual man-machine interactions is the exploitation of new and creative approaches to presentation of situation awareness and other information to the pilot. It is our intention to explore the feasibility and benefits of dynamic holograms as a pilot to aircraft systems interface device. The need for improved situation awareness involves informing the pilot of other aircraft, ground threats and terrain in his area and their spatial relationship to his aircraft. A three-dimensional display would be ideally suited for this purpose, however, it would have to be generated for display in real-time. i.e., 20 to 30 times per second depending on aircraft dynamics. Dynamic holograms have previously been accomplished through the use of motion picture film. The film medium, however, is not capable of responding to the pilot's actions or to changing external conditions and is therefore unsuitable for application in a fighter cockpit. This research would involve a number of areas including holographic media materials, holographic generation, optical processing and dynamic holography applications. There are many applications for this technology. This technology could provide 3-D virtual imagery in the cockpit of future aircraft without the weight vs. display field of view and scene complexity constraints currently encountered with helmet display technology. Airborne situation awareness, threat response, target recognition and identification, mission effectiveness and survivability should be improved using this technology. This technology could also support ground based applications including mobile and laboratory flight simulators, rapid cockpit prototyping, pilot-aiding artificial intelligence knowledge base development and avionics development workstation environments.

AF87-150. TITLE: Transfer Alignment Techniques for Hypersonic Weapon Applications

OBJECTIVE: To model and simulate alignment techniques for hypervelocity weapon applications.

DESCRIPTION: For a number of aircraft, the alignment transfer from the aircraft's inertial navigation systems (INS) to the weapon's INS differ in the following manner: 1) the data that is transferred between the aircraft and weapon and 2) the excitation requirements levied upon the aircraft to create weapon inertial navigation unit (INU) measurement observability. Hypersonic endoatmospheric flight (Mach 5-20) will have to address issues which are not

necessarily key drivers for subsonic or supersonic weapons initialization. Considering today's transfer alignment techniques, an effort must be performed to identify technical deficiencies relative to hypersonic applications. The Phase I objective of this effort is the examination of current weapon INU alignment techniques and proposed hypersonic applications to identify shortfalls in the current methodologies. This program will be partitioned into two major tasks as follows:

a. Research current bomber/fighter-carried weapons INU transfer alignment techniques/requirements and determine applicability for hypersonic weapon environments.

b. Investigate potential hypersonic weapon delivery concepts and postulate weapon INU alignment requirements.

At the conclusion of the Phase I effort, the contractor will produce a final report, which (1) documents current weapon alignment methods for both bomber and fighter aircraft, (2) postulates alignment requirements for hypersonic weapons, (3) recommends current alignment techniques or proposes potential alternate approaches for hypersonic weapon applications, and (4) proposes a follow-on effort to model and simulate alignment techniques for hypervelocity weapon applications.

AF87-151. TITLE: Ada for Embedded Systems

OBJECTIVE: To develop a packaging processor dependent code which is practical and feasible for embedded systems.

DESCRIPTION: Recently, the Ada programming language has been mandated for use in all software programs in the DoD. Along with Ada's ability to divide programs into logical blocks (packages) came the idea that one could design programs for embedded systems using any Ada compiler. This would be done by keeping the processor dependent sections separate from the rest of the code. The logic of the program could then be debugged and the machine dependent part of the code modified for any particular processor. Using this method much code could be reused, resulting in large productivity gains and improvements in code quality and maintainability. The idea sounds good; however, there is some skepticism as to how the program will behave in a highly parallel or embedded environment as opposed to the single processor environment on which it was developed. The objective of this effort is to develop a packaging processor dependent code separately as mentioned which is practical and feasible for embedded systems.

AF87-152. TITLE: High Linear Electro-Optics Effect Film Development

OBJECTIVE: To develop a high linear electro-optics effect film material with properties that can operate at frequencies up to 100 GHz.

DESCRIPTION: Future Air Force electronic and current microwave devices are hampered by the limited number of techniques available to test their operation without adversely affecting them. The electro-optics techniques pursued at Stanford and Rochester show promise for non-invasive testing. Non-invasive testing is a photonic/nonlinear optical technique that can significantly enhance electronics repair and avionics maintenance and expand diagnostic

options for VHSIC. In order for non-invasive circuit testing to be useful as a general technique, a material needs to be developed which has a very high linear electro-optical effect like merocyanine dyes. The material should be one that could be developed in place much like polyimide photoresist, and one which would orient the active pendent either during deposition through techniques like spinning or by surface tension. The objective of this program is to develop a material with the above properties that can operate at frequencies up to 100 GHz. The development of such a coating would allow electro-optical sampling of high speed electronics without the need for direct contact with the device under test.

AF87-153. TITLE: Intelligent Ada Compiler

OBJECTIVE: Research to find ways of producing super optimized Ada code.

DESCRIPTION: Research is needed to find ways of producing super optimized Ada code. Currently a skilled programmer can write an assembly language program which is faster and takes up less space than an Ada compiler can. Some of today's Ada compilers have as many as thirty optimizations, but these optimizations detect only the most simple of patterns in Ada source code. The ability of an Ada compiler to generate object code more efficiently than a human being would be a major turning point in our ability to build more complex software systems. With such an intelligent compiler in place, considerations of program size and efficiency could reasonably be ignored in most of the software development process allowing the designers to spend more time designing and organizing the system itself.

AF87-154. TITLE: Multi-Functional Device Integration

OBJECTIVE: Explore areas of device, circuit and interconnect technology which will lead to the ultimate goal of full wafer union.

DESCRIPTION: The objective of this technical effort is to explore areas of device, circuit and interconnect technology which will lead to the ultimate goal of full wafer union. This is defined as the successful integration of microwave, digital, analog and electro optical devices on a common substrate for the purpose of increased performance and system reliability. To accomplish this will require dedicated efforts in such areas as a) transmission of high speed data and high frequency information from point to point on the wafer; b) development of selected area crystal growth techniques for producing non-lattice matched material systems which will allow the fabrication of different device structures in close proximity; c) investigation of optimized interconnect concepts which can provide the means for combining varied functions or building blocks into a complex functional unit; d) modeling techniques which accurately predict the advantages and limitations of the wafer level union concept and can be used to lower the risks associated with design and implementation. Additional areas which will require attention if wafer level union is to become a reality include fault tolerance, redundancy, testability, yield improvement and packaging. The above description defines a broad area of interest and proposals addressing individual or combined areas are encouraged as long as they clearly focus on the final objective.

AF87-155. TITLE: Compact, High Efficiency Multi-Aperture Broad Spectrum Sensor

OBJECTIVE: Demonstrate the feasibility of producing a compact, high efficiency multi-aperture broad spectrum sensor.

DESCRIPTION: This is a three-phase effort to determine the feasibility of building a broad spectrum sensor sufficiently compact to fit into a hypersonic interceptor aircraft. This sensor could detect and identify vehicles employing stealth technology. Phase I will study the sensor technologies and project the size, weight, and power requirements for the sensor technology if used in a broad spectrum sensor to identify stealth vehicles. Phase II will make component tradeoffs and select a set of sensors that can realistically be combined to produce a compact, high efficiency multi-aperture broad spectrum sensor. During this phase a hypothetical design shall be proposed by the contractor. During Phase III the contractor will procure available "off-the-shelf" sensors and demonstrate the feasibility of the system.

AF87-156. TITLE: Smart Communications

OBJECTIVE: Explore the potential of Artificial Intelligence (AI) techniques for providing the decisions and control required to effect optimum employment of aircraft on-board communications resources.

DESCRIPTION: The highly complex electromagnetic environment projected for battlefields of the year 2000 and beyond offers exceptional challenges to the communication system designers. The complexity and dynamic nature of the communications threat severely limit the utility of preplanned strategies for employment of the on-board communications systems. The avionics system must sense the electromagnetic environment in which it is operating and in real time devise optimum strategies for employment of the available communications assets. System frequencies, modulation, power levels, cycle time, low probability of intercept (LPI) techniques, and antenna control are representative of the decision parameters to be considered in finding this optimum solution. The number of alternatives to be considered, the dynamic nature of the environment, extent of analyses required, and the demand for real time response exceed the capabilities of the already burdened pilot and conventional computational approaches. The objective of this effort is to explore the potential of Artificial Intelligence (AI) techniques for providing the decisions and control required to effect optimum employment of aircraft on-board communications resources. Phase I will provide concept definition, evaluation/feasibility demonstration of technology alternatives and specific requirements for technology demonstration in Phase II.

AF87-157. TITLE: Avionics Integrity Program (AVIP)

OBJECTIVE: To develop engineering techniques, methodologies, method of work and criteria which support durability oriented design, manufacturing, repair and modification of avionics hardware/equipment systems and failure free life predictions.

DESCRIPTION: The following programs are of specific interest:

a. Environmental Reliability of Electronics Equipment. Environmental stress screening is used during the production phase to transform latent part and workmanship defects in equipment into detectable failures for their elimination prior to delivery to the ultimate users of the equipment. Current practice is to establish the proper stress types, levels and durations by trial and error, experience, company policy and/or negotiations. If the environmental stress is too severe, too much useful life is consumed by the stress screening process. Weak stress screen will identify some latent defect allowing products containing defects to be delivered to the ultimate user. The net effect of current environmental stress screening techniques is that the shipped equipment contains fewer latent defects and displays a lower failure rate as the result of having been screened. Unfortunately, there exists no means of knowing how much useful life exists in the shipped equipment (useful life is the number of or amount of exposure time to critical environmental stress conditions until the occurrence of the first failure in an item). Ideas and concepts are being sought for an environmental proof test or process for electronic equipment which would: (1) be used as a 100% screening process, (2) consume only a small amount of the equipment's useful life, (3) provide insight into the amount of useful life available for usage, and (4) provide results in a short period of time.

b. Instrumentation of Printed Circuit Boards/Integrated Circuits. Instrumentation is presently used to measure the environment and stresses in gross area of aircraft electronic systems. High density packing of electronic systems on operational military aircraft requires that system reliability have the highest standards. Increasing and predicting the failure free operating period of these systems is imperative to extend the operational status of combat aircraft and to reduce associated cost of ownership. Localized stress environment within a system must be monitored and analyzed to give an accurate picture of conditional probability. Ideas and concepts are being sought for using micro-miniature stress sensors, as they become available, to measure environmental induced stresses on small, individual components of major weapons systems. Methods are also being sought for instrumenting critical areas of aircraft sensor systems and the recording of the data. The developed technology will be used to instrument systems leading to the AVIP failure free operating period prediction model validation tests.

AF87-158. TITLE: Electro-Optical Control Devices

OBJECTIVE: To design and fabricate an electro-optical mechanism for use in a ten turn potentiometer, optical shaft encoder or optical synchro which provides conductive contact and a conductive surface.

DESCRIPTION: Optical synchros and electro-optical potentiometers are devices that normally operate by having contact between a conductive contact and a conductive surface. This produces noise and wear which lower the reliability and shorten the life of the instrument. Also, because of system requirements (i.e. low noise, linearity, temperature compensation, vibration, humidity), these items are very costly. Using advances that have been made in solid state lighting (i.e., lasers, light emitting diodes, electroluminescense, etc), it should be possible to produce a mechanism that would be stable and durable

enough to be used in a ten turn potentiometer, an optical shaft encoder or an optical synchro. It is, therefore, required that an electro-optical mechanism be designed and built that demonstrates its adaptability, durability, and stability over a wide temperature range (40^oF to 160^oF) for use in the aforementioned devices.

AF87-159. TITLE: Enhanced Thermal Energy Storage in Clothing

OBJECTIVE: To develop and demonstrate an enhanced thermal energy storage fabric.

DESCRIPTION: Present techniques for producing arctic or cold weather protective clothing involve the use of layers of insulating materials. It is obvious that there is a limit to the effectiveness of this technique. As the layers increase in thickness, the bulk and surface area of the material increases, thus the heat loss due to the increase in surface area exceeds the insulating properties of the materials. Also, the increase in bulk makes it virtually impossible to accomplish any meaningful tasks while wearing the materials.

There is at present a requirement for development of gloves and/or socks that can be used to keep a person comfortable for up to four (4) hours at -55^oF. The only way this may be accomplished is the development of a method of enhanced thermal energy storage in the fabric. The technique to be used shall be safe for the wearer even if there is a breakdown in the material. Also, the fabric that touches the skin of the person shall be of the type that is known to cause few, if any, allergic reactions (i.e., cotton or cotton/polyester or some other natural or hypo-allergenic material).
The object of this feasibility demonstration is to show that a low-bulk layered fabric can be produced that has enhanced thermal energy storage that is durable, stable, waterproof and cleanable. The fabric must be amenable to the manufacture of articles of clothing without the development of new technology to implement the use of the fabrics.

AF87-160. TITLE: Aeronautical Systems/Subsystems Research

OBJECTIVE: To develop new concepts and innovations for aeronautical systems/subsystems.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of aeronautical systems/subsystem research, development, and procurement. It is also intended to provide latitude to the innovator to include areas not specifically addressed by other specific aeronautical topics. This general area covers the full spectrum of Air Force aeronautical missions (i.e., tactical, airlift, mobility, strategic, transatmospherics, etc). Emphasis is placed on potential Long Term Planning Concepts. Topics as diverse as new weapon system concepts and improved operational techniques can be submitted. Some other areas of interest are high energy fuels, maintenance free systems, facility threat, countermeasures, innovative research and development organizational concepts, etc. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF87-161. TITLE: Investigation of "Smart Skin" Technology/Effects on Aircraft Design

OBJECTIVE: To investigate the impact of using increased areas of the aircraft surface as sensor/processor avionic elements.

DESCRIPTION: Gallium arsenide (GaAs) technology coupled with efforts in the microwave integrated circuits (MICs) technology and signal processing areas will result in increased use of skin line avionics. Future aircraft will have increased thermal and mechanical stresses, as well as increased use of composite structures, which will require integrated structure/avionics design considerations. The total radiating/processing elements of the smart skin sensors may be less than 1-inch thick. This integration will present major design problems in the consideration of thermal, mechanical and electromagnetic interference (EMI) design factors.

AF87-162. TITLE: Artificial Intelligence Applied to Aeronautical Systems

OBJECTIVE: To develop Artificial Intelligence applied to Aeronautical Systems.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of artificial intelligence (AI) as applied to aeronautical systems. This topic is meant to provide the innovator with latitude to include Air Force mission areas of AI application not addressed by other specific aeronautical topics. Areas of special interest include knowledge based systems applications to integrated sensor data fusion, cockpit/air battle management, diagnostics/repair, etc.

AF87-163. TITLE: Systems/Subsystems in Support of Special Operations Forces (SOF) Missions

OBJECTIVE: To develop Systems/Subsystems in support of SOF.

DESCRIPTION: Special emphasis should be placed on the requirements of sensors, defensive systems, and special support equipment in support of the SOF missions. These missions would cover the spectrum of local counter insurgency to global SOF deployments. In the systems area, emphasis is placed or developing different vehicle's performing various SOF missions.

AF87-164. TITLE: Multi-Role Global Range Aircraft

OBJECTIVE: To develop methodologies for the evaluation of Multi-Role Global Aircraft.

DESCRIPTION: An analysis/synthesis of a Multi-Role Global Range Aircraft for strategic offense missions is required. The missions would include quick response transport, stand-off Cruise Missile Carrier, command, control, communications and intelligence (C^3I) platforms, stand-off reconnaissance platform, tanker, etc. The proposal could cover one or two of the above mission areas for analysis/synthesis with the results providing parametric trade-off data which can be evaluated in the context of

contributing to the synthesis of a Multi-Role Global Range Aircraft. Trade-off parameters would include speed, range, capacity, survivability, etc. The Multi-Role Global Aircraft would be projected for deployment in the 21st century.

AF87-165. TITLE: Electronic Warfare Effectiveness Displays

OBJECTIVE: To develop electronic warfare effectiveness displays for integration into a battle management workstation.

DESCRIPTION: Interactions among electronic warfare elements within a high-threat environment has become increasingly complex with different radars, jammers, weapons, and warning devices. Any battle management workstation, used for simulations or for combat, would require that these interactions be visible to the user. A display methodology is needed which will (1) help the user cope with the complexity of electronic warfare interactions, (2) focus his attention on global effectiveness of Air Force systems, and (3) support the user's decision processes. The methodology should be based on practical knowledge and experience with electronic warfare systems rather than theoretical models, and on the user's point of view rather than the programmer's. The display should minimally show the effects of signal propagations, threat signal processing, fire control, and weapons guidance. Color and three-dimensional enhancements should be considered. For simulations of high-threat environments in which all effects within the simulated environment would be known, the display should support countermeasures design and analysis with a methodology structured to support the user's needs. It should be adaptable to different simulation programs and data inputs from combat situations.

AF87-166. TITLE: Internally Mounted Space Suit Heads-Up Display

OBJECTIVE: To develop designs and advanced concepts for an internal helmet-mounted display, electronic documentation software for on-orbit tasks, and voice activation.

DESCRIPTION: YMX is developing designs and advanced concepts for an internal helmet mounted display, electronic documentation software for on-orbit tasks, and voice activation for such a display. We are also developing neutral buoyancy tasks to test its practical applications.

A helmet-mounted display for electronic documentation will (1) reduce training time for complex extra-vehicular activity (EVA) tasks by providing real-time images of next steps in complex sequences (forward looking to completion), (2) increase productivity of expensive EVA time, (3) aid fault isolation and trouble shooting, (4) give the ability to see "other" sides of spacecraft thereby reducing the need for translation, (5) provide access to detailed maintenance data without large mass and volume, (6) display environment control and life support (ECLS) and manned maneuvering unit (MMU) data to EVA astronauts or intra-vehicular personnel, and (7) enable hands-free operation of the system via voice control.

SD/YMX requires that an underwater video display be built. The display shall attach to the outside of an Extravehicular Mobility Unit Helmet and shall not obstruct the normal forward field of view. The display shall include a 100 foot umbilical for video signal and electrical power. Video signals and power will be supplied by the government. The display shall operate at depths up to 40 feet (fresh water).

AF87-167. TITLE: Innovative Technologies/Methodologies to Reduce Space System Costs

OBJECTIVE: To develop innovative technologies/methodologies to reduce space system costs.

DESCRIPTION: The cost of space systems and access to space must be reduced. Technologies and methodologies should be studied which have the promise of reducing costs for launch processing, launch operations, satellite design and construction and satellite on-orbit control.

Phase I should be trade studies and analysis of cost saving proposals or technologies. Studies should be top level tradeoffs between current processes or technologies compared to potential cost saving processes or technologies. Top level implementation and development plans should also be proposed.

In launch processing, possible aspects to be studied include: paper systems, processing procedures, horizontal vs. vertical etc. In launch vehicles, technologies leading to lighter, stronger structures and more efficient engine and fuel designs are of interest. Also, the launch operations manpower requirements, possible cost savings in the launch configuration and stack on pad vs. move to pad after stack are possible topics. The best mix of manned vs. unmanned lift vehicles and their optimal cargo capacities is another candidate for study. In satellite design, tradeoffs between expensive long life satellites and cheaper shorter life configurations can be reviewed. Satellite construction could be reviewed for more efficient methods of construction, greater long lead procurement authority, multiple buys, greater emphasis on robotics, etc. In satellite control, modeling to determine the optimal mix of ground based and space based data processing is an area of interest. All concepts for data processing, including artificial intelligence, are possible topic areas. New hardware, e.g. VLSI (Very Large Scale Integration) could be studied for satellite control and design. All study work must lead to reducing the cost of the use of space.

Phase II is dependent on Phase I. Phase II will be development and proving of technologies and processes, from the Phase I effort, for their cost saving potential.

AF87-168. TITLE: Remote Sensing of Meteorological Parameters

OBJECTIVE: To develop spaceborne sensors to measure meteorological parameters.

DESCRIPTION: The purpose of this effort is to develop spaceborne sensors to measure meteorological parameters to the accuracy required by the Air Force.

The sensors in use by the Defense Meteorological Satellite Program (DMSP) meet the primary requirement for cloud cover imagery. The sensors provide much useful data, but improvement in their capability is desired. New measurement techniques or approaches, improvements in critical sensor components, subsystems, and proof of concept sensors for use on future DMSP spacecraft are desired. These improvements must be consistent with the limited power and size onboard the spacecraft. Examples of the parameters desired are clear air turbulence, surface temperature, snow and landlocked ice cover, soil moisture and sea state. Snow and landlocked ice cover are qualitatively measured using imagery from the optical line scanner. It can be determined snow cover under cloud free conditions only (resolution 0.3 nautical mile).

AF87-169. TITLE: Cleaning, Alignment and Calibration of Large Space-Based Antennas

OBJECTIVE: To develop and demonstrate methodology for cleaning, aligning, and calibrating large space-based antennas to reach their true resolution capability.

DESCRIPTION: NASA has already demonstrated significant manned on-orbit capabilities in the support of civilian space activities and plans still greater use of extra-vehicular activity (EVA) in future programs. EVA allows space assembly of precision surfaces, such as optical and millimeter wave reflectors, with very large apertures without constraint from launch vehicle volume and mass limits. This results in increased resolution of electromagnetic sensing systems and a huge cost avoidance by eliminating the requirement for development of a heavy lift launch vehicle and elaborate ground handling systems.

The technology exists for assembly of these large systems, but we still need to demonstrate the ability to clean, align, and calibrate large space-based antenna to reach their true resolution capability. Methods should be proposed for accomplishing these tasks for various wavelength regions with manned EVA or machine systems. Also, describe the technical feasibility of demonstrating each of the methods on the ground or in a manned neutral buoyancy facility.

AF87-170. TITLE: Space Systems Logistics Capabilities Assessment Model

OBJECTIVE: To develop a formal modeling system for assessing the planned support capabilities of current space systems to insure there is satisfactory system integration.

DESCRIPTION: There is no formal modeling system for assessing the planned support capabilities of current space systems to measure the adequacy of each logistics element or to test the interaction between operations and support functions to insure there is satisfactory system integration. Program managers cannot currently "tax" their developing systems through simulation modeling to anticipate support shortfalls or to flag supportability cost drivers. Program managers need the means to predict the adequacy of selected support options and relate those advantages/disadvantages to the overall assessment of the system's viability. Space Division planners need an

interactive model which will assign representative values to operational and support parameters and permit a top-down assessment of system operating vulnerabilities as well as O&M cost drivers. Such a modeling system should also allow planners to ask "what if" questions and work around uncertainties.

AF87-171. TITLE: Doppler Lidar Wind Sensors and Differential Absorption Lidar (DIAL) Sensors

OBJECTIVE: To develop active Lidar sensors for Defense Meteorological Satellite Program (DMSP) spacecraft capable of satisfying validated requirements for wind, temperature, moisture, and visibility.

DESCRIPTION: Spaceborne Lidar sensors have the proven potential of measuring global horizontal wind velocities by measuring the doppler frequency shift of laser radiation backscattered from atmospheric aerosols. Spaceborne DIAL sensors have the potential of measuring temperature and moisture profiles with great accuracy and vertical resolution using the absorption bands of O_3 and H_2O respectively. There is also potential for quantified measurement of visibility using Lidar sensors. The goal is to develop active Lidar sensors for Defense Meteorological Satellite Program (DMSP) spacecraft capable of satisfying validated requirements for wind, temperature, moisture, and visibility.

The difficulty lies in the development of laser sensors with the necessary lifetime (two to three years at a 10 Hz repetition rate), wavelengths (tunable for DIAL), energy (2-10 joules/pulse), laser efficiency, lightweight optics, efficient detectors, and accurate data processing algorithms.

AF87-172. TITLE: Autonomous Control System for Low Orbital Transfer Vehicle (OTV) for Global Positioning System (GPS)

OBJECTIVE: To develop techniques for low cost control of the OTV attitude and engine firing during its spiral orbit transfer.

DESCRIPTION: The GPS Program Office is considering the use of an Electric OTV to deliver replenishment satellites in a timely manner to their operational orbits. The Electric OTV shows promise of significant cost savings over conventional chemical upper stages. However, before the vehicle can be deployed an autonomous control system must be developed.

Innovative techniques are sought for low cost control of the OTV attitude and engine firing during its spiral orbit transfer. This assessment should include hardware, software, operational strategies and system configuration trade-offs to minimize both change in velocity and eclipsing during orbit transfer from low earth orbits (of inclinations between 28.5° and 57°) to a (ground uplinked) final mission orbit (either 10,900 nmi, 55° inclination or geosynchronous). The design shall consider the following:

a. Sensor and computing capability.
b. Ability to provide continuous control.
c. Ability to orient a one-axis degree of freedom solar array normal to the solar flux utilizing sun sensors mounted on the array and the on-board controller to provide yaw motion.

d. Trade-offs in the use of additional hardware including a rate gyro assembly, GPS receiver and reaction control system.
e. Modifications to system which will allow on-orbit rendezvous and docking via telepresence.
f. Estimate of subsystem masses and configurations necessary to support an electric OTV.

AF87-173. TITLE: Beam Synchronization and Coherence Techniques for a Distributed Sparse Array (DSA) of Spacecraft

OBJECTIVE: To investigate options for and assess beam synchronization and coherence techniques for a distributed sparse array system for follow-on development.

DESCRIPTION: DSA is a space-based, thinned phased array radar system in which each array element is a separate spacecraft. These spacecraft, called mini-radars, cooperate to form a single coherant radar beam. DSA has a number of desirable characteristics, which include very fine angular resolution, ASAT survivability, mainlobe jammer nulling, and possible lower total system cost than a monolithic space-based radar. Two of the key technical issues for DSA are the synchronization and coherence techniques for a DSA system. Beam synchronization techniques to be investigated should include the use of internal timing references (e.g. atomic clocks) and external sources (e.g. timing signals from ground station). The use of ground targets with known radar cross section (e.g. corner reflectors and transponders to act as focusing targets should be investigated as a means of achieving beam coherence.

AF87-174. TITLE: Determination of Countermeasures to Bistatic Radar

OBJECTIVE: To determine if effective countermeasures to Bistatic Radars are possible, and develop design options/approaches for countermeasure devices.

DESCRIPTION: A bistatic radar system is generally considered ECM resistant because the receiver is radio-silent, and jamming directed towards the transmitter does not affect the receiver. The purpose of this research effort is to determine if effective countermeasures to bistatic are possible. Emphasis should be placed on countermeasures to hybrid bistatic radar systems (i.e. bistatic radar using a space-based transmitter and airborne receivers).

AF87-175. TITLE: On-Orbit Costs Between a Distributed Sparse Array Radar System and a Monolithic Space-Based Radar System

OBJECTIVE: To develop methodology for the comparative analysis of the cost of operation of space based radar systems.

DESCRIPTION: The concept of a distributed sparse array addresses the two basic concerns of space systems, cost and survivability: cost by use of production line techniques in producing simple, single string satellites; survivability by distributing mission requirements among a large number of satellites that collectively act as a single system. An attack is therefore more likely to degrade rather than destroy mission capability.

This effort shall develop analytical models which will be used to accurately compare the total on-orbit costs between a distributed sparse array (DSA) radar system and a monolithic space-based radar (SBR) system. Specialized knowledge is required in the area of space-based radar and, in particular, in cost modelling. A cost savings is expected because the DSA breaks down the function of the satellite into smaller portions which can be handled by a greater number of satellites. By decreasing the size and complexity of the satellite and by increasing the number of satellites, production line techniques can be utilized and so production costs could decrease. However, the increased total system weight of a DSA system over a monolithic SBR system will result in increased transportation charges, which may offset the decreased production cost.

AF87-176. TITLE: Ultraviolet Linear Array Detector

OBJECTIVE: To develop an ultraviolet linear array detector.

DESCRIPTION: Defense Meteorological Satellite Program (DMSP) anticipates flying a sensor to obtain ionospheric characteristics by measuring electron density profiles. The ionosphere's geographic mapping comes from these measurements as inferred from UV radiation intensities at wavelengths of 1356 Angstroms and in a band from 1500 to 1700 Angstroms. Phase I consists of an assessment of the state-of-the-art for UV-sensitive detectors, including solid state devices, vacuum tubes, etc. Include sensitivity, geometry, repeatability of device capability and manufacturability in the considered issues. Phase I deliverables would be in the form of a concept study and a Phase II proposal for pilot fabrication of a device array.

AF87-177. TITLE: Signal Processing Architecture for a Distributed Sparse Array (DSA) Radar System

OBJECTIVE: To develop signal processing architecture for a Distributed Sparse Array Radar System.

DESCRIPTION: DSA radar is a space-based, thinned phased array radar system in which each array element is a separate spacecraft. These spacecraft, called mini-radars, cooperate to form a single coherent radar beam. DSA radar has a number of desirable characteristics, which include very fine angular resolution, ASAT survivability, mainlobe jammer nulling, and possible lower total system cost than a monolithic space-based radar. The purpose of this effort is to develop potential signal processing architectures that emphasize the distribution of signal processing throughout the mini-radars and will allow processing reconfiguration in the event of a single mini-radar failure or destruction.

AF87-178. TITLE: Transmitter/Receiver Coordination Techniques for a Bistatic Radar System

OBJECTIVE: To develop and provid techniques for providing transmitter/receiver coordination for a hybrid bistatic radar system.

DESCRIPTION: Bistatic radar has recently received considerable attention as a way to enhance radar cross section, to provide covert operation of the

receiver, and allow the transmitter to operate in a safe, defensible location. One of the technology issues for bistatic radar is the coordination between transmitter and receiver. Target position errors will occur if a timing mismatch exists between transmitter and receiver, and also if the receiver miscalculates the relative transmitter position. The purpose of this study is to develop and provide techniques for providing transmitter/receiver coordination for a hybrid bistatic radar system i.e. bistatic radar using a space-based transmitter and airborne receivers). Possible synchronization techniques to be investigated include the use of atomic clocks and the transmission of a timing reference to the transmitter and/or receiver. The use of various navigational techniques (e.g. inertial, TACAN, and GPS) for providing accurate airborne receiver position information should be investigated. Techniques for providing space-based transmitter position information to the airborne receivers should also be developed.

AF87-179. TITLE: Nitrogen Tetroxide, Monomethyl Hydrazine Compatibility With Nickel

OBJECTIVE: To provide reliable information of the interactions between N_2O_4 and MMH propellants and their products of combustion with nickel and nickel-based alloys.

DESCRIPTION: An advanced development thruster design having an electroformed nickel injector is exhibiting injector flow passage erosion on the discharge face. Thruster durability/life requirements are being degraded.

High-performance space engines are being developed which use non-cryogenic fuels and oxidizers such as nitrogen tetroxide (N_2O_4) and monomethyl hydrazine (MMH). Increased use of N_2O_4 and MMH for space applications emphasizes the need for better knowledge of these propellants' materials compatibilities, especially at elevated temperatures. Existing qualitative data in the propellant handbooks suggest that nickel is not compatible with $N_2O_4$and is also incompatible with hydrazine. A research effort is proposed to conduct a thorough search and review of current literature. The objective of the study will be to provide reliable information of the interactions between N_2O_4 and MMH propellants and their products of combustion with nickel and nickel-based alloys. The results obtained shall be useful for selection of injector fabrication materials. Efforts shall be conducted to establish the effects of various mechanisms of corrosion and material behavior associated with temperature environment, propellant composition and impurity levels. Investigation shall include, but not limited to: study of chemical interactions between N_2O_4 MMH and their combustion products with nickel;/nickel-based alloys, etc. Inhibition techniques, surface treatments, thermodynamic properties of reaction products, and nitridation processes which may be useful in understanding and preventing the degradation phenomena should be included. The effort should also identify additional laboratory tests and test equipment for follow-on effort required to acquire data not previously available for comprehensive evaluation of the problem.

AF87-180. TITLE: Advanced Fuel Cells

OBJECTIVE: To design a 45-volt DC fuel cell and to assess the cost and schedule to construct and space-qualify it.

DESCRIPTION: One of the greatest constraints in the upcoming Neutral Particle Beam Integrated Experiment is weight and one of the largest weight drivers is the Radio Frequency (RF) power supply. A preliminary study has shown that the weight of the power supply could be cut nearly in half if instead of using the current Space Shuttle 28-volt DC fuel cell, a 45-volt DC fuel cell could be used. The proposed work would be to design a 45-volt DC fuel cell and to assess the cost and schedule to construct and space-qualify it. Volume for such a fuel cell design will be defined by the Neutral Particle Beam Integrated Experiment prime contractors. In addition, the proposed fuel cell must operate in the pulsed mode with 27,000 amp pulses down to 350 microseconds with only a 2-3% voltage drop.

AF87-181. TITLE: Solid State Laser Sources for Eye-safe Coherent Lidar

OBJECTIVE: To develop solid state laser sources for eye-safe coherent lidars.

DESCRIPTION: Although Air Force plans for space based wind sensing Doppler Lidar have included the use of a carbon dioxide TEA laser, rapidly advancing technology in the fields of solid state and diode lasers makes the development of an eye-safe solid state coherent source for this application appear a realistic possibility. The terms of size and weight, such a system would have definite advantages. However unless diode laser pumping capability is developed in conjunction with the solid state rod or slab laser source, the carbon dioxide laser will have a significant advantage in efficiency and lifetime. On a spacecraft with an extremely limited power budget, efficiency is of overriding concern. Operation at a wavelength greater than 1.45 micron is desired for reasons of eye safety since a space based Lidar by nature will illuminate populated regions on the surface. Such an eye-safe laser would also have potential applications in certain ground and aircraft systems such as target designators near troop concentrations and for optical communications. In order to be considered for space based applications, the laser and its pump must have lifetimes capable of supporting operations for at least two unserviced years and be space qualifiable. Efficiency should be greater than 2%. Identification of the most promising laser materials and their relevant characteristics along with recommendations on potential system configurations are sought under this contractual effort.

AF87-182. TITLE: Scanning Transceiver System for Space Based Lidar

OBJECTIVE: To develop space based wind sensing Doppler Lidar systems.

DESCRIPTION: Development of space based wind sensing Doppler Lidar systems requires the investigation of possible scanning coaxial transceiver designs compatible for use aboard free-flying spacecraft. The Doppler Lidar will utilize heterodyne detection and therefore require diffraction limited optics at the transmitter wavelength, taken to be 9 micron for the purpose of this effort.

The optical telescope will be of the one-meter class with less than 10% obscuration of the primary. An evaluation shall be made of the relative merits between on- and off-axis systems as well as continuous and step scanning techniques. In addition the investigation should include other system and spacecraft related concerns including, but not limited to: long and short term pointing errors; alignment; size; weight; power requirements; lag angle compensation; momentum compensation, and and thermal stability. Where appropriate, trade-off analysis should be accomplished.

AF87-183. TITLE: Electric Fields and Plasma Structure in the Solar Corona

OBJECTIVE: To perform research to measure and model macroscopic electric fields in solar flares, loops, prominences and spicules.

DESCRIPTION: The primary objective of this work area is to obtain information on the heating mechanisms in solar flares and on the mechanisms by which mass is ejected from the sun--leading to disturbance in the interplanetary space and terrestrial environments. This work will lead to improved understanding of the energetics of flare loops and coronal heating which will provide physical mechanisms for processes that eject mass from the sun. This in turn will support the efforts of Air Force Geophysics Laboratory's Solar Research Branch to improve forecasts of the solar activity that creates hazards for Air Force systems and personnel operating inspace and upsets AF C^3I activities. Little work has been done to measure and model macroscopic electric fields in solar flares, loops, prominences and spicules. Knowledge of magnitude and morphology of these fields will place critical constraints on models of solar activity processes and permit the development of models for the heating of the solar coronal plasma.

AF87-184. TITLE: Rugged Precise Mirror Position Translation and Controller

OBJECTIVE: To develop a Michelson interferometer to study ultra-violet atmospheric radiation from space platforms

DESCRIPTION: Interferometer spectrometers have been flown in space, both on free flying satellites and on the Space Shuttle, but their application has been limited to the infrared region. The throughput and multiplex advantages of the Michelson interferometer could be of great value in improving our ability to study ultraviolet atmospheric radiation from space platforms. The implications for doing so for wavelengths down close to 0.1 micrometer are a formidable degree of control of the placement of a moving mirror which must be positioned and translated with precision, repeatability and with adequate freedom from tilt and shear.

In Phase I it is not required that this general capability be demonstrated with radiation of wavelength as short as 0.1 micrometer. Rather, it is recommended that components be selected so that, with some convenient ultraviolet wavelength, a clear and convincing demonstration is made that the desired interferometer spectrometer performance at vacuum ultraviolet wavelength (at least 5 Angstrom resolution at 0.1 micrometers) is readily achievable with the proposed mirror drive and control for 25mm optics. The Phase I deliverable should include sufficient hardware and software items to

demonstrate, test and quantify that performance. Finally, vendors must keep in mind that the intended application may involve free-flying or shuttle borne space flight. At this stage flight qualified piece parts and end products are not required, but size, weight and power needs should be kept small; it should be plausible to proceed from a successful Phase I with the design and delivery of an end product which is able to withstand the rigors of the launch and space environment then start up and perform as demonstrated on the ground.

Assuming that the Phase I product is acceptable, in Phase 2 the desired deliverable is a full up laboratory prototype instrument which does demonstrate the performance specified in the interferometer mode, at wavelengths as short as allowed by lithium fluoride optics (about 0.11 micrometers). During Phase 2, major milestones will include adequate performance following what amounts to space qualification testing of major assemblies and the entire end product, but the actual deliverable is not expected to be fully flight qualified.

AF87-185. TITLE: Flowing Afterglow Design

OBJECTIVE: To design and construct a flowing afterglow apparatus.

DESCRIPTION: Proposals are requested for the design (Phase I) and construction (Phase II) of a flowing afterglow apparatus. The design of the instrument should allow for the following: (1) generation of metastable species through either discharge or laser excitation, (2) the introduction of secondary species to allow the study of excited state reactions, (3) multiple window ports along the length of the chamber to allow concentration and lifetime measurements, (4) an interchangeable detection method allowing either mass spectrometry or spectroscopic detection.

AF87-186. TITLE: Application Optimized Dual Energy Digital Tomosynthesis/ Computed Tomography

OBJECTIVE: To develop improvement in X-ray digital tomosynthesis.

DESCRIPTION: Current work in X-ray digital tomosynthesis is general in nature as opposed to application specific. Carbon-carbon and filament wound composites offer unique hardware and software inspection challenges, since they are layered thin wall porous structures. Defects may consist of variations in density and chemical species as well as voids and cracks. Several areas of advancement in hardware configuration, sensor technology, and software are envisioned which will improve the spatial resolution of density and chemical specie variations that are undetectable with current inspection techniques. One means of accomplishing this is through the use of dual energy digital tomosynthesis. This program will assess the feasibility of making significant improvements in X-ray digital tomosynthesis as applied specifically to thin walled carbon-carbon and filament wound composite structures. It is envisioned that an assessment of the current digital tomosynthesis capabilities be made by scanning actual composite parts that will be supplied to the contractor by the Air Force Rocket Propulsion Laboratory (AFRPL). The results will be studied and a digital tomosynthesis machine will be designed that is application specific to composite materials. A program plan should be prepared and submitted for Phase II approval. In Phase

II, an application specific prototype digital tomosynthesis machine will be built and demonstrated on composite materials. The prototype system will be delivered to the AFRPL at the end of the project.

AF87-187. TITLE: Optimize Ammonium Nitrate for Solid Rocket Propellants

OBJECTIVE: To formulate and characterize ammonium nitrate with many different additives; to improve combustion efficiency and burn rate, without degrading performance.

DESCRIPTION: Ammonium nitrate (AN) is an attractive oxidizer for booster propellants because it is low-cost and "clean," i.e. produces no HCl as an exhaust product. Also, because no HCl is produced, secondary smoke, which results from water vapor condensation, is eliminated. This is especially important in minimum smoke tactical missile applications. The problems with AN are that it undergoes a phase change in the operating temperature range, aluminum combustion efficiency is poor, and propellant burn rates are low. Commercially available phase stabilized ammonium nitrates, (PSANs) do not address combustion or ballistic problems. In addition, the stabilizing agents are usually inert and, therefore, degrade performance. The objectives of this program are to formulate and characterize ammonium nitrate with many different additives; inorganic, organic, or energetic. In addition to providing phase stabilization, these additives should be selected based on their ability to improve combustion efficiency and burn rate, without degrading performance. Small samples will be prepared and characterized. Phase II efforts may include preparation of kilogram quantities of the most promising formulations for Air Force evaluation.

AF87-188. TITLE: New Concepts to Enhance Future Spacecraft Survivability

OBJECTIVE: To provide adequate protection for spacecraft from hostile sensors and weapon threats.

DESCRIPTION: Future U.S. spacecraft will face various hostile threats including directed energy (DEW) and kinetic energy (KEW) weapons. Original concepts and enabling technologies are sought to provide adequate protection for spacecraft from hostile sensors and weapon threats. New concepts can include lightweight, compact shields that can be quickly generated or deployed to protect the spacecraft. Concepts may also include spacecraft hardening or spacecraft stealth technologies. Proposed ideas should consider spacecraft protection/shielding from threats such as sensor detection and tracking, KEW and DEW weapons, electromagnetic pulse (EMP) and close-range nuclear bursts. Concepts must include ideas beyond simply proposing new spacecraft materials. Proposed concepts can incorporate unique application of technologies currently under development.

AF87-189. TITLE: Robotics for Solid Propellant Mixing Laboratories

OBJECTIVE: To investigate the use of robotics and other automated processing techniques as a means of reducing the cost and improving the safety for solid propellant mixing.

DESCRIPTION: Mixing of novel solid rocket propellants in R&D laboratories requires extensive safety precautions due to the explosive nature and, in some cases, unknown hazards of the materials. Current operations used throughout the industry involve elaborate facilities, are very labor intensive, and still contain an element of risk to the personnel involved. This program will investigate the use of robotics and other automated processing techniques as a means of reducing the cost and improving the safety of these operations. Specifically, the contractor shall develop, or modify existing equipment to automate a one-pint solid propellant mixing operation. Operational steps that should be considered for automation include ingredient weighing and pre-batching, ingredient addition, on-line monitoring of relevant mix parameters, propellant casting, and cleanup. Emphasis shall be placed on approaches that minimize human intervention and enhance safety. Modifications to the mixing equipment are acceptable if necessary.

AF87-190. TITLE: Thermodynamic Vent System (TVS) Optimization

OBJECTIVE: To develop analytical effort that is required to identify solutions to optimizing the termodynamic vent system for use in long life space systems.

DESCRIPTION: Long term storage of cryogenic fluids in space has been identified as a critical requirement for many military space systems of the 1990's. The results of the Forecast II technology plan and of past Air Force Rocket Propulsion Laboratory (AFRPL) studies, Long Term Cryogenic Storage and Compact LOX Feed System, have indicated that an optimized thermodynamic vent system, which is well integrated with passive thermal insulation components, would provide the capability to store cryogenic fluids in space for periods of up to ten years. An analytical effort is required to identify solutions to optimizing the thermodynamic vent system for use in long life space systems. Technical interests are duty cycles and flowrates of the TVS, its location within the multilayer insulation surrounding the tank, para-to-ortho hydrogen conversion trade-offs, Joule-Thomson valves requirements, heat transfer analysis, and approaches for system optimization. Critical solutions which have broad applications to long term cryogenic fluid storage systems will be identified for follow up demonstration programs.

AF87-191. TITLE: Sensors and Actuators for Fine Shape Control

OBJECTIVE: To develop concepts for lightweight, high bandwidth sensors and actuators capable of detecting and correcting low frequency structual vibration as well as maintaining correct shape configuration.

DESCRIPTION: Future Air Force space missions will be unprecedented in both their size and flexibility. As a result, greater reliance will be placed on active control to maintain the shape of the structure and reduce vibrations in the presence of disturbances such as attitude control, temperature variations, power system noise, and exhaust noise. Sensors and actuators that can detect and compensate for these disturbances are needed. The size of these structures makes the use of many sensors and actuators prohibitive from a cost, weight and complexity standpoint. Consequently, lightweight, high bandwidth actuators and sensors are necessary in order for mission

requirements to be met. Investigations into the possibility of using distributed actuators and sensors to overcome the shortcomings of discrete systems would be advantageous to the Air Force. Distributed systems would provide more exact information as to location and magnitude of a deflection while reducing overall system weight and complexity.

The Air Force Rocket Propulsion Laboratory is interested in investigating concepts for lightweight, high bandwidth sensors and actuators capable of detecting and correcting low frequency structual vibration as well as maintaining correct shape configuration.

AF87-192. TITLE: Twenty-First Century Propulsion Concepts

OBJECTIVE: To develop new non-conventional propulsion concepts for launching and maneuvering payloads in space

DESCRIPTION: Bold, new non-conventional propulsion concepts are solicited for launching and maneuvering payloads in space. Twenty-first century propulsion includes all propulsion concepts other than conventional chemical rocket propulsion which is presently used by the Air Force and NASA. More specifically, revolutionary concepts are sought in each of the following major categories: (1) solar propulsion, (2) electric propulsion, (3) nuclear propulsion including both fission and fusion, and (4) Esoteric concepts which could include theoretical developments of zero point quantum dynamic energy of vacuum space and multidimensional theories which predict the current paradigm of physics plus new phenomenology which would be of benefit to space propulsion. Particular attention will be given to revolutionary concepts based on sound scientific principles offering quantum increases in performance and mission capability.

AF87-193. TITLE: Innovative Aperture Concepts for Optical Imaging

OBJECTIVE: To identify innovative aperture concepts for co-optical imaging techniques, which provide superior image quality while at the same time reducing the total collecting area of the optics to a minimum.

DESCRIPTION: Various coded aperture techniques (e.g., random arrays, non-redundant, and uniformly redundant arrays) have been proposed to provide high-quality imagery in the microwave, optical, and x-ray electromagnetic regimes. Since these techniques collect radiation over small subareas of a larger effective aperture, application of such techniques to optical imaging may provide novel means of achieving high-resolution imagery at low cost compared to systems with fully-filled apertures. The purpose of this effort is to identify innovative imaging techniques which provide superior image quality while at the same time reducing the total collecting area of the optics to a minimum. Under this effort, the awardee shall propose and evaluate one or more sparse/coded aperturing concepts for application to optical imaging. For this effort, we will assume that each elemental subaperture of the collecting array is many hundreds of wavelengths in size. To evaluate the imaging performance of these aperturing schemes, the awardee shall propose specific and well-defined image quality measures (e.g., a two-point resolution criterion, some

measure of reduced edge-ringing, mean-square image error). For this study, the awardee may consider the imaging system to operate under any (coherent, partially coherent, or incorherent) object illumination condition he deems appropriate to the aperturing concept(s) considered.

AF87-194. TITLE: An Expert System for Satellite Survivability Analysis

OBJECTIVE: To develop applications of Artificial Intelligence (AI) for satellitesurvivability/vulnerabilityanalysis

DESCRIPTION: Application of artificial intelligence (AI) for satellite survivability/vulnerability analysis may be feasible through the use of knowledge-based expert systems. The Air Force Weapons Laboratory is currently using solid models with radiation transport codes or other applications codes to analyze system and subsystem vulnerability and radiation susceptibility. A knowledge base needs to be able to store the collective scientific, engineering, and design expertise in addition to being integrated into an expert system with an intelligent computer-aided-design (CAD) interface. Most engineering analysis depends on the availability of a geometric computer model of the system. Once developed, a single model can be used for all subsequent design analysis, and manufacturing tasks. CAD systems, more specifically solid modeling systems, can be used effectively in many different types of analysis including structural analysis with discrete components, kinematic and kinetic analysis of mechanisms, mass properties analysis, static loading and dynamic analysis, thermal analysis, power distribution analysis, radiation shielding analysis, and stability analysis. The feasibility of such an expert system which integrates an intelligent solid modeling system with the necessary engineering analysis software needs to be investigated. We also need to determine whether the knowledge base of the expert system could contain, in one place, a satellite model and geometrical descriptions, design descriptions, test data, operating data, and analytical results. It should also contain all the specific and judgment knowledge of satellite design experts. Data input required by the analysis software can be prepared automatically and graphical output of analysis results should be displayed accordingly by the expert system.

AF87-195. TITLE: Applications of Nonlinear Optics for Phase and Image Retrieval Through Aberrating Media

OBJECTIVE: To develop applications of nonlinear optics for phase and image retrieval through aberrating media.

DESCRIPTION: Optical phase conjugation has been used to reconstruct aberrated images by double passing the distorting medium. Recently, phase conjugate techniques have been suggested and demonstrated for single pass aberration correction. This effort will assess several facets of the issue. First, how well do the currently published techniques of single pass image reconstruction work, i.e., what is the fidelity of reconstruction and what are the limits to the process. Second, alternative methods of single pass image reconstruction via phase conjugation should be explored. Four wave mixing, phase print through on two beam coupling, and stimulated scattering are candidate technologies. Also, the applicability of each method of image reconstruction

for tactical (short range, endoatmospheric) surveillance and strategic (long range, exoatmospheric) imaging should be addressed. This effort should address wavelength limits, materials, detection, and image processing; resulting in proposed applications for Phase II development.

AF87-196. TITLE: High Power Microwave (HPM) Integrated Circuit Screening Criteria

OBJECTIVE: To develop a screening process, or chip design criteria, to produce integrated circuits hardened to HPM.

DESCRIPTION: A need exists to better understand the failure mechanism of integrated circuits to HPM radiation. Using that understanding, develop a screening process, or chip design criteria, to produce integrated circuits hardened to HPM. The proposed effort involves three phases:

Phase I: Analyze and study failed components to develop a fundamental understanding of the failure processes and a theoretical hardening approach.

Phase II: Screen or produce a prototype batch of hardened chips. Test to determine the degree of hardness improvement.

Phase III: Commercially produce the hardened chips.

AF87-197. TITLE: Material Optical Properties Measurements for Repetitive Pulse Laser Effects

OBJECTIVE: To develop new methods for measuring material optical properties that are needed to evaluate pulse laser effects.

DESCRIPTION: New methods for measuring material optical properties are needed for repetitive pulse laser effects studies. The principal optical properties of interest are indepth absorptivity, plume absorptivity, and temporal surface absorptivity and reflectivity. Problems involved include the separation of small measurement signals from the strong scatter noise in the same bandwidth. Once the problems are solved, the new measurement methods will be integrated into a repetitive pulse laser effects diagnostic package.

AF87-198. TITLE: Low Noise Optical Amplifiers Using Nonlinear Optics for Phase Control

OBJECTIVE: Examine Low Noise Optical Amplifiers Using Nonlinear Optics for Phase Controls.

DESCRIPTION: This effort will examine two families of nonlinear optics effects for low noise optical amplifiers: Stimulated Scattering and wave mixing. It should involve a broad literature search and analysis of the applicability of these technologies for phase preserving optical amplifiers. Applicability issues include fidelity of phase imprint from the weak beam onto the amplified beam, noise issued, and scaleability.

Raman amplifiers use Stimulated Raman Scattering to imprint the phase of a seed stokes beam onto a powerful pump beam. Backseeded Stimulated Brillouin Scattering imprints seed phase onto the backscattered power beam.

Wave mixing processes include four wave mixing, which under the right conditions has a phase conjugate reflectivity of much greater than unity, and hence acts as a phase preserving amplifier. Two beam coupling has recently been introduced as a method of switching intensity from one beam to another, while preserving phase. Parametric mixing, up-conversion, and down-conversion may also prove useful as nonlinear optics phase preserving amplifiers.

The end product of Phase I will be a conceptual analysis and computer model of the effectiveness of several key technologies for optical amplification (including models of phase and image fidelity). Technologies analyzed shall include, but not be limited to, those listed in the second and third paragraphs, above.

The end product of Phase II will be experimental hardware and data from a selected, optimized key technology for optical amplification. The data shall include conclusions for the applicability of the technique for Air Force applications, including amplified images for surveillance and amplified, phase preserved optical beams for target designation.

AF87-199. TITLE: Conceptual Development of Survivable Networking for the Distributed Sparse Array of Spacecraft

OBJECTIVE: To develop a survivable adaptive network for a distributed Sparse Array of Spacecraft.

DESCRIPTION: Air Force has a need for developing a survivable adaptive network concept for the innovative space system concept called Distributed Sparse Array of Spacecraft. This is a concept consisting of small, inexpensive satellites that work in unison to provide the capability for a survivable mission function. For this system to be implemented, it is essential that a survivable adaptive network concept be developed. This adaptive network concept is essential in order that the proposed constellation can work with any one satellite being the master. In addition, it is essential that they maintain time synchronism such that high data rate traffic can be accommodated with the capability of each spacecraft having the capability to be a master. This system might be used as communication or sensor platforms. Link performance in stressed environments, interconnectivity of links, and multimedia transmission are essential ingredients of this system.

AF87-200. TITLE: Two Phase Flow and Heat Transfer in Microgravity

OBJECTIVE: To perform research in two phase flow and heat transfer in microgravity.

DESCRIPTION: Thermal management will be a crucial part of many Air Force space operations. A boiling/condensing (two phase) power cycle or heat transport loop may be necessary to fulfill mission objectives. The contractor shall perform a complete literature review to determine the status of research in

two phase flow and heat transfer in microgravity. At the end of Phase I the contractor shall provide a plan for an experimental program to extend and clarify knowledge of important parameters in this field. The aim of the program shall be the development of design correlations for determining pressure drops and heat transfer coefficients. At the conclusion of Phase II the contractor shall deliver the experimental hardware to be tested in microgravity.

AF87-201. TITLE: Innovative Data System for Inertial Components

OBJECTIVE: To develop a stand-alone system to handle large quantities of classified data for inertial components.

DESCRIPTION: Inertial component reliability tracking and performance analysis systems require expeditious handling and manipulation of large quantities of classified data. Current performance and capacities of readily available microprocessor equipment and software offer viable alternatives to existing main frame systems. A design utilizing proven hardware and devices that will provide stand-alone capability with network options needs to be developed. The effort shall provide a complete design, identifying hardware and software that will handle the present inertial components evaluation data and provide for economical expansion to satisfy future requirements. Automated transfer of data from existing systems is mandatory. Cost of the system must be scoped.

AF87-202. TITLE: Hemispherical Resonating Gyro (HRG) Evaluation

OBJECTIVE: To develop an HRG for ICBM inertial guidance.

DESCRIPTION: Inertial guidance system cost, accuracy, mechanization and reliability are largely a function of the instruments. The HRG shows promise of a high performance gyro that could simplify system mechanizations and improve reliability and Life Cycle Cost. An evaluation of the HRG is desired. The evaluation should include an error budget analysis, analyses of available data to establish accuracy potential, and a reliability assessment. System integration requirements should be scoped to include effects on overall system performance, reliability and cost. Phase 2 effort shall include the design, fabrication and test of an HRG.

AF87-203. TITLE: Mobile Missile TEL Analysis

OBJECTIVE: To develop methodologies for analysis of ground vehicle capabilities.

DESCRIPTION: Investigate and develop methodology for accurately determining the payload and performance of foreign ground vehicles, particularly transporter-erector-launchers (TELs). Data available is limited and past estimates have always had large uncertainties. If successful, this effort shall advance the state-of-the-art for estimating ground system capabilities and provide analysis to enhance the design process for domestic military and commercial vehicles.

AF87-204. TITLE: Advanced Basing System Concept Definition Assessment

OBJECTIVE: To develop the analytical tools to assess concept definition and performance characteristics of various basing modes for land-based ICBMs.

DESCRIPTION: The Advanced Basing Division addresses a variety of single mode and multimode concepts. In order to evaluate the feasibility and cost effectiveness of these concepts, the system effectiveness, survivability, and operational effectiveness must be determined. The contractor will develop the analytical tool to assess concept definition and performance characteristics of various basing modes for land-based ICBMs, including Peacekeeper and Small ICBM. Contractor must have extensive experience in system effectiveness studies and system effectiveness analytical tools. As a minimum, concepts to be addressed should include a hardened launch portal deep base/shallow tunnel complex, as well as other possible ICBM basing variants.

AF87-205. TITLE: "SAFETY/COMPUTER" for Nuclear Weapons/Power and Safety Critical Computer Controlled Systems

OBJECTIVE: To develop a computer system to permit safety critical software to operate in an environment resistant to hardware faults and failures.

DESCRIPTION: Methods are needed to allow complete read capability of all memory locations for load verification. Furthermore, the hardware should be capable of tolerating multiple internal failures without affecting the operation of the verified Nuclear Safety Cross-Check Analysis (NSCCA) software. The computer hardware should also be able to detect transient failures during software execution. The hardware should be based in a high reliability, high production yield, computer-on-a-chip (or other highly integrated type) technology. The system should allow for fault isolation and should be maintainable; but should not require maintenance during five-year operating cycles with a predicted reliability of .9999 and a probability of a single bit/register error of less than 1×10^{-9} during each five-year operating cycle. The computer will have application in Nuclear Weapons Systems, Nuclear Power Plants, Hazardous Operations, Strategic Defense Initiative and numerous commercial safety critical computer controlled systems.

AF87-206. TITLE: Low Cost Alternate Launch System for Flight Testing

OBJECTIVE: To develop low cost alternatives to launch systems for flight testing.

DESCRIPTION: In order to flight test small ballistic Reentry Vehicles (RVs), the Air Force is forced to use a complete missile system retired from the active inventory. In many cases, payloads of less than 50 pounds cost more than three million dollars to launch on a ballistic trajectory into the Kwajelein atoll. For research and development programs, this cost can be prohibitive, leading to a minimum of actual flight testing and great uncertainty in the final performance of a fielded system. Under this topic the contractor would do the following:

a. Examine other methods of placing small RVs into a ballistic trajectory (e.g., ground-based electromagnetic rail guns).

b. Determine the cost and feasibility of building a system.

c. Prepare a phase II hardware development and test program plan.

The successful contractor must demonstrate an understanding of the requirements for a ballistic trajectory and the expected launch loads and ascent environments.

AF87-207. TITLE: Stress Analylsis of Hypervelocity Models Under High G-Loads

OBJECTIVE: To develop methodologies for a three-dimensional analysis of the stress waves produced in a hypervelocity model.

DESCRIPTION: A three-dimensional analysis of the stress waves that are produced in a hypervelocity model that undergoes the high g-loads present in the Range G facility at the Arnold Engineering Development Center. These models are subjected to accelerations as high as 150,000 g's for a short time. The length of time that the model is accelerated can vary but is generally on the order of 50 to 70 milliseconds. The acceleration history starts with a series of short duration (fractions of a millisecond) pulses produced by shock waves, rises to its peak shortly after start, and then decays until muzzle exit. The models are complex with a lucite base, aluminum and copper necks, yielding threads, and a carbon/carbon nosetip.

AF87-208. TITLE: ICBM Deep Base Fire Protection System

OBJECTIVE: To develop an ICBM deep base fire protection system definition.

DESCRIPTION: An ICBM deep base could consist of several hundred miles of interconnected underground tunnels which might contain a wide variety of hazardous, toxic, radioactive items. Fuel cells or other chemical power sources could require large volumes of liquid oxygen, chlorine, methane, or other flammable or corrosive liquids and gases. A nuclear power plant may also be used. Handling of ICBMs will require storage of nuclear materials as well as nighly volatile rocket propellants. In addition, site geologies may introduce a variety of flammable gases including methane.

To alleviate the danger of explosions and fire, as well as mitigate damage should an accident occur, an integrated fire protection system must be defined. This system should address active as well as passive measures. Emphasis on innovative approaches to damage control is imperative. Energy demands and toxic by-products must be minimized since the entire base will be self contained after a large scale attack. Analysis of current concepts should address points of failure as well as possible solutions.

AF87-209. TITLE: Egress Boring Machine (EBM) Disc Cutter Development

OBJECTIVE: To develop a new disc cutter specifically for the egress scenario.

DESCRIPTION: The current, baseline deep basing concepts use 15 ft diameter, disc cutter equipped EBMs to bore an egress shaft to the surface at an advance rate of 80 feet per hour. The shafts would be bored from an underground base to the surface at angles of between 45 and 90 degrees from the horizontal for a total length of 1000 to 2000 feet through 10-20 ksi unconfined compressive strength rock. Current EBM development is using state-of-the-art, 17-inch diameter, constant cross section disc cutters as a baseline. The objective of this program is to develop a new disc cutter specifically for the egress scenario. Taking advantage of the limited boring distance, and the medium strength rock, the principal requirement for no maintenance replacement of the cutters suggest an EBM disc cutter be developed to provide penetrations of greater than 1.5 inches and simultaneously allow for larger bearing capacity to take greater thrust loads. Innovative development and test programs are sought to improve and demonstrate cutter and bearing life.

AF87-210. TITLE: Optimal Design of a Smaller Reentry System

OBJECTIVE: To develop a design for a new ballistic reentry vehicle carrying a 50-200 kiloton warhead for use on ICBMs.

DESCRIPTION: Payload and volumetrics of existing and protected US ICBM system should be considered. Materials, sizing, cost drivers, and required technology should be addressed. Product should include cost and schedule estimates for follow-on detailed design and development work.

AF87-211. TITLE: High Lift to Drag Vehicle Design

OBJECTIVE: To develop a reentry vehicle taking advantage of high lift to drag vehicle designs and conventional maneuvering reentry vehicles.

DESCRIPTION: Investigate potential advantages and disadvantages of high lift to drag vehicles vs conventional maneuvering reentry vehicles. Technical areas should include energy management, maneuver capability, payload capability, aerothermodynamics, structures, guidance and propulsion systems. Compatibility with ballistic missile delivery system is a must.

AF87-212. TITLE: ICBM Electronics Hardening Analysis

OBJECTIVE: To develop improvements in hardening ICBM electronic components.

DESCRIPTION: Advanced Ballistic Missile Defenses (BMD) may utilize a variety of weapons to inflict lethal damage on ICBMs. These weapons can include Neutral Particle Beams, Nuclear Pumped Lasers as well as conventional nuclear weapons. While a variety of kill mechanisms may exist for these weapons, electronic destruction or upset is the principal concern of this topic. Due to the nature of the weapon characteristics, the electronics associated with the reentry vehicles and post-boost vehicles are the principal component to be considered (i.e., guidance, arming and fuzing). The offeror should identify the components susceptible to these environments and levels needed to cause upset or destruction, and finally innovative methods and approaches to solutions. The solutions can encompass circumvention techniques as well as hardening.

AF87-213. TITLE: Acceleration Hardened 84 GHz Transmitter

OBJECTIVE: To develop a 894 GHz microwave transmitter that can be launched in a hypervelocity model.

DESCRIPTION: The transmitter should be designed so that it can be installed in a conical model which has a length of about 4 inches. The transmitter should be designed to withstand launch accelerations up to 100,000 g's.

AF87-214. TITLE: Measuring Electron Densities in Boundary Layers and Wakes

OBJECTIVE: To develop measuring techniques for electron densities in boundary layers and wakes.

DESCRIPTION: Measurement techniques are needed to determine the electron densities in laminar and turbulent boundary layers and near wakes (free shear layer) on a hypersonic model. These models are sphere-cones which are about 4 inches long with a base diameter of 2.5 inches and which have velocities up to 22 kft/sec. Typical boundary layer dimensions are on the order of 0.01 to 0.2 cm. The range of electron densities for which measurements are needed is approximately 10^8 electrons/cm^3 in the near wake to 10^{17} electrons/cm^3 in the boundary layer. Model view times are short, on the order of nanoseconds. The technique devleoped should be verified under actual conditions in a hypervelocity range facility.

AF87-215. TITLE: Monte-Carlo vs Navier-Stokes Model

OBJECTIVE: To determine the validity of the Navier-Stokes model at low Reynolds number and low density rarified flow regimes.

DESCRIPTION: The validity of Navier-Stokes model at low Reynolds number and low density rarified flow regimes has not been carefully and clearly defined. Even when the shock-slip (i.e., the non-Rankine-Hugoniot condition) and the body-slip (e.g., the velocity and temperature slip) effects are included, the Navier-Stokes calculations gradually deviate from the measured data as the altitude becomes higher. On the other hand, Monte-Carlo analysis usually gives reasonably accurate results at high altitude but calculations become too time consuming as the altitude becomes lower. The altitude at which one can switch from one formulation to another is not clear. Currently, it is not certain that the results from the two models would overlap. Innovative analysis is sought to identify the domain of validity of the Navier-Stokes model and to ascertain the reliability of the Monte-Carlo formulation. Specifically the effects of Koudsen layer and the collision models (specular vs diffusive) should be addressed in the Monte-Carlo analyses. Comparisons of numerical results with flight data and ground measurements are required.

AF87-216. TITLE: Anti-Ballistic Missile (ABM) Defense Radar Jammers on Deployment Ballistic Upper Stages (BUS)

OBJECTIVE: To design and develop a radar jammer on the fourth stage deployment BUS.

DESCRIPTION: The ability of reentry vehicles to penetrate through an ABM environment is directly associated with the quality of the radar track available to the defense. Radar jammers have the ability to degrade this information. At present, programs have been started to investigate jammers accompanying the reentry vehicle throughout its trajectory. In all tradeoff studies, however, the fourth state deployment BUS has been ignored as a site for a potential jammer. The contractor will do the following in phase I:

(1) Determine feasibility through power allocation requirement studies, initial antenna calculations, and threat
(2) Perform an initial packaging study
(3) Prepare a Phase II hardware development and test program plan.

AF87-217. TITLE: Target Damage Assessment by Ballistically Delivered Sensors

OBJECTIVE: To design and develop a sensor for target damage assessment.

DESCRIPTION: Accurate damage assessment is critical for targeting second wave launches. Properly delivered sensors can provide needed information for this purpose. One method worth exploring is the use of an RV to dispense sensors in the target area after the remaining RVs have penetrated.

AF87-218. TITLE: Anti-Simulation Devices

OBJECTIVE: To develop anti-simulation devices.

DESCRIPTION: To develop approaches, techniques, and investigate payoffs for anti-simulation of radar, optical, and combined radar/optical signatures of reentry vehicles and decoys in penetration of anti-ballistic missile defenses.

AF87-219. TITLE: Trajectory Optimization

OBJECTIVE: To develop numerical methods for complex trajectory problems.

DESCRIPTION: New and innovative numerical methods are needed to solve complex trajectory problems. Current methods require end-to-end simulation which is costly and time consuming. Methods are needed to quickly optimize end game trajectories for maneuvering reentry vehicles with alternative terminal fix constraints against a given set of defenses. The optimacity criteria will be "miss distance."

AF87-220. TITLE: Muck Disposal System for Multiple High Speed Tunneling Operations

OBJECTIVE: To develop muck disposal system for multiple high speed tunneling operations.

DESCRIPTION: Construction of an ICBM deep base will consist of separate, simultaneous, high advance rate tunneling operations. A system of removing

and spoiling the large amount of generated muck must be developed. The system should be capable of following individual tunneling operations as well as merge with that of other systems to remove and waste the muck from the underground construction area.

AF87-221. TITLE: Ultra High Effectiveness Heat Exchangers and Ultra High Efficiency Heat Pumps

OBJECTIVE: To develop ultra high effectiveness heat exchangers and ultra high efficiency heat pumps.

DESCRIPTION: The ICBM Deep Basing program is considering the use of heat transfer to rock strata for cooling. In order to cool the underground habitat, a heat pump with extremely high efficiency is desired to minimize use of electrical power and provide the highest possible heat pump temperature. Heat exchangers (air-to-water, condensers, and evaporators) of extremely high effectiveness would also contribute to reaching this goal.

The SBIR contractor should develop innovative concepts for such equipment and demonstrate sub-scale models.

AF87-222. TITLE: Passive Sensor Array Design

OBJECTIVE: To design and construct a new innovative passive sensor array.

DESCRIPTION: Sensor will use either seismic or acoustic information to accurately locate multiple events in time and space. The Phase I effort will concentrate on developing theory and identifying power requirements, reliability problems and technology gaps.

AF87-223. TITLE: Hybrid Communications Satellite Design

OBJECTIVE: To design a hybrid, multi-frequency band communications satellite.

DESCRIPTION: Using innovative solutions to complex design techniques, provide a conceptual design of a hybrid, multi-frequency band communications satellite. Identify power requirements, boost requirements, reliability problems and any new technologies which need to be developed.

AF87-224. TITLE: Expulsion Techniques

OBJECTIVE: To develop expulsion mechanisms for reentry vehicles.

DESCRIPTION: There is a need to develop a method of expelling up to 300 small objects of approximately ten pounds total weight from a small reentry vehicle from high endoatmospheric to low altitudes. The effort is needed to define various feasible concepts such as expelling the objects from the base of the vehicle clearing the wake. The effort must address the aerothermodynamic implications of different techniques on vehicle design and electronic packaging of the vehicle and its payload section.

AF87-225. TITLE: Solid Propellant Ballistic and Mechanical Property Modeling

OBJECTIVE: To develop modeling techniques for solid propellant ballistics and mechanical properties.

DESCRIPTION: Advanced missiles designs subject the missile structure and propellants to severe stresses well beyond those of current designs. The combination of ballistic and mechanical properties required far exceed those of the state-of-the-art. This effort would focus on developing a model of solid propellants consisting of energetic binders and various filler materials of varying geometry. The thermo-mechanical properties to be considered include stiffness, creep, relaxation moduli thermal expansion and thermal conductivity.

AF87-226. TITLE: Post-Boost Vehicle (PBV) Master/Slave Guidance

OBJECTIVE: To design and develop a post-boost vehicle (PBV) master/slave guidance.

DESCRIPTION: Provide conceptual designs for master/slave guidance concepts as applied to single ICBMs carrying multiple PBVs with the booster having the master guidance system for boost and the individual PBVs providing a maximum of 350 feet per second delta velocities.

AF87-227. TITLE: Impurity Ions in Heatshields

OBJECTIVE: To develop analytical models for predicting the rate that impurity ions are injected into the boundary layer.

DESCRIPTION: The plasma sheathing and wake signature of a reentry vehicle (RV) is dependent on the electrons produced in the boundary layer of the vehicle. A major source of these electrons in certain altitude regimes are the impurity ions present in the heatshield. Of particular interest is when the flow in the boundary layer becomes turbulent. There is some evidence that indicates the release of impurity ions may be temperature sensitive rather than simply proportional to the ablation rate. An analysis is required to determine the characteristics of these impurity ions as they are injected into the boundary layer. This analysis should determine if it is possible to predict, via an analytical model, the rate that impurity ions are injected into the boundy layer and the effect it has on the plasma sheathing and wake signature of the vehicle. An assessment to determine if ground tests can be performed to validate the analytical model should also be included in this analysis.

AF87-228. TITLE: Parabolized Navier-Stokes (PNS) Code Upgrade

OBJECTIVE: To upgrade Navier-Stokes codes for computing reentry flow fields.

DESCRIPTION: Innovative methods are sought to upgrade the existing PNS (parabolized Navier-Stokes) codes for computing the high speed three-dimensional reentry flowfields. Specifically, the new formulations should not be sensitive to marching step size and can calculate the surface laminar and turbulent heat transfer accurately. Numerical viscosity should be avoided if possible. Analysis must also address the selections of optimim grid/coordinate for the geometries. Numerical algorithm must be able to handle internal or imbedded shocks or contact surface. Finally, the formulation must have the potential to extend to chemical/thermal nonequilibrium flows.

AF87-229. TITLE: Maneuvering Reentry Vehicle (MaRV) Sizing Analysis

OBJECTIVE: To develop computer adaptable innovative designs and engineering analyses for maneuvering reentry vehicles (MaRV).

DESCRIPTION: Development of computer adaptable innovative designs and engineering analyses are sought for preliminary estimates of maneuvering reentry vehicles (MaRV) (e.g., weights, center-of-gravity locations, and size/shape). The algorithms should evaluate the vehicle configuration (e.g., nose geometry, multi-conic body, etc.) control concepts and control size requirements for particular trajectories. The methodology should employ efficient but accurate aerodynamics, static stability analyses, nose overhang calculations, heatshield thickness estimations and trajectory computations. The analyses should address both bank-to-turn and skid-to-turn concepts.

AF87-230. TITLE: Radar Frequency (RF) Propagation Prediction Through Nuclear Clouds

OBJECTIVE: To develop an analytic model which can be used to calculate propagation of electromagnetic radiation at radar frequencies (RF) through nuclear clouds.

DESCRIPTION: Target detection through nuclear clouds at frequencies of 1.0 to 35 GHz is of interest. An electromagnetic model of the nuclear cloud in the RF should be done for middle and high altitude bursts. Existing RF data for nuclear bursts and simulated bursts should be reviewed and factored into the model.

AF87-231. TITLE: Optical Processing for Ballistic Missile Defense

OBJECTIVE: Applications of optical processing techniques for ballistic missile defense.

DESCRIPTION: Areas of interest include:

a. Applications of optical processing systems for RV discrimination. Systems which use infrared, visible (reflected laser or natural) light or radar signals as input are of interest.

b. Optimal use of optical signal processing in a BMD radar system design. Effective hybrid optical-digital system for reducing or conditioning radar return signals as well as configurations capable of background and noise suppressions, target feature enhancement and directional filtering are among those of interest. Waveform, architecture and internal implications are to be assessed.

AF87-232. TITLE: Wind Tunnel Shear Stress Gauge Development

OBJECTIVE: To develop instrumentation for measuring hypersonic boundary layer shear stress on smooth and rough walls.

DESCRIPTION: This gauge should have sensitivity and accuracy in both laminar and turbulent flow. The wind tunnels under consideration are the Arnold Engineering Development Center tunnels A, B, and C. One potential application is to measure the two components of surface shears which are usable to define the local limiting streamline direction. This gauge should be robust enough to operate in the continuous wind tunnel and hot environments (e.g., adiabatic wall). Also, it should be sensitive enough to measure the cross flow (secondary flow) shear.

AF87-233. TITLE: Kinetic Kill Countermeasures

OBJECTIVE: To develop ICBM evasion techniques/maneuver mechanisms.

DESCRIPTION: Advanced Ballistic Missile Defenses may utilize a variety of weapons to inflict lethal damage on ICBMs. These weapons can include Directed Energy Weapons and Kinetic Energy Weapons(KEW). This effort shall focus on negating KEW threats. Previous studies have determined that conventional hardening is impractical due to severe weight penalties, however, evasion tactics appear promising. Due to the nature of the threat, ICBM boosters and post-boost vehicles are the principal concern. Evasion maneuvers against KE vehicles with velocities of 1 to 30 km/sec (with and without homing) are of interest. The offeror should be able to determine the magnitude of the maneuvers required, the effects of the maneuvers on the systems, and innovative methods or techniques to initiate and control the maneuvers.

AF87-234. TITLE: Heatshield/Structure Attachment

OBJECTIVE: Develop methods for heatshield/structure attachment.

DESCRIPTION: The size of cutouts for future antenna windows has the potential to increase to a point where simply bonding the heatshield to the substructure may not be adequate for tape-wrapped heatshields, particularly with high maneuvering loads. Alternative thermal protection systems, which may include specialty segments which can survive, are desired which will survive the loads and not severely constrain the vehicle weight, size, etc.

AF87-235. TITLE: Nuclear vs Conventional Weapons Effectiveness Model

OBJECTIVE: To develop a methodology/model comparing the lethality effectiveness of nuclear and conventional weapons.

DESCRIPTION: Develop a methodology/model comparing the lethality effectivess of nuclear and conventional weapons that have the same payload (weight and volume) constraints. Then, with the physical damage parameters listed in the Physical Vulnerability Handbook - Nuclear Weapons and the Joint Munitions Effectiveness Manuals (JMEM), identify what conditions it would be best to use one weapon type over the other to ensure the highest probability of target kill while keeping collateral damage to a minimum.

AF87-236. TITLE: ICBM Control Analysis

OBJECTIVE: To develop variable stability controls for ICBMs.

DESCRIPTION: Determine the utility of incorporating variable stability control equations into ICBM controls instead of flying fixed gain equations (with variable switching) for enhanced stability. Phase 2 follow-on efforts will focus on the most promising methods for further development.

AF87-237. TITLE: Brilliant Guidance for ICBMs

OBJECTIVE: To develop brilliant guidance systems for ICBMs.

DESCRIPTION: Analysis of the integration of advanced acquisition and tracking algorithms, passive and active sensors, monolithic millimeter wave integrated circuits, compact fuzing algorithms to future ICBM missions is sought. Advanced sensors, processors, algorithms and software are needed to enable the development of reentry systems with autonomous capabilities to perform updates for accuracy improvements or to find, recognize and home-in on relocatable targets.

AF87-238. TITLE: High Energy Density Propellants for ICBMs

OBJECTIVE: To develop high energy density propellants for ICBMs.

DESCRIPTION: Analysis of the use of chemically stable elements whose electrons reside in a higher energy state than occurring naturally for use in advanced ICBM designs is sought. Availability of propellants having 10 times the energy density of conventional propellants will support the development of smaller missiles, larger payload capability or both. To support this analysis, an analytic tool used to evaluate the payoffs and penalties associated with these propellants is also desired. Characteristics desired include specific impulse, burn time, throw weight, lift-off weight, range and environmental impact but are not limited to these.

AF87-239. TITLE: Synthetic Aperture Radars

OBJECTIVE: To reduce synthetic aperture radar requirements for large amounts of computer processing.

DESCRIPTION: Synthetic aperture radars require large amounts of computer processing (millions of floating point operations per second) to obtain real time images. Identify methods to reduce this requirement and check the validity of those methods. Quantify the image degradation (i.e., false alarms, missed images) versus the reduction of computation requirements.

AF87-240. TITLE: Antenna Window Ablation

OBJECTIVE: To develop an analysis tool to calculate the three-dimensional ablation histories on the antenna windows of maneuvering reentry vehicles.

DESCRIPTION: The window configurations can be either multi-element phase-array button geometry or a large monolithic element. The formulation must address the streamwise as well as spanwise (azimuthal) ablation variations. The interactions between the heatshield and window ablations are the essential features of the models. Internal conduction and radiation should be included. The window materials can be melting abators and/or sublimators. The windows can be located at any location on the vehicle and the flowfields must include the angle of attack effects.

AF87-241. TITLE: Research Instrumentation

OBJECTIVE: To stimulate the development of new scientific instruments for laboratory and industrial applications.

DESCRIPTION: Progress in fundamental research often depends on use or invention of new diagnostic techniques which can provide better insight into the fundamental processes or phenomena under study. Development of improved and novel scentific instrumentation will enable researchers to make more useful measurements per unit of time, to make measurements to a greater degree of accuracy, and to make measurements in places and under conditions not now possible. It may also permit quality instruments to cost less and be more reliable. This effort seeks to improve the basic function of scientific instruments, and to reduce the cost and improve the reliability of instruments which would enhance the scientific productivity of this country. Areas of interest include, but are not limited to, laser combustion diagnostic testing, vision testing equipment, advanced biogenetic tests for toxicity, new mathematical algorithms allowing improved computer program performance, optical information processing, accelerator mass spectroscopy, aerodynamic flow measurement devices, and improved material and process diagnostic systems. The Phase I effort should provide a review of various concepts and design options for the proposed type of instrumentation. The Phase II effort would then develop a prototype or prototypes of the best concept/design alternatives, leading to Phase III

commercialization of the instrument. Evaluation of proposals will include the following factors:

a. Potential value to the Air Force Research program.

b. Potential for transition to Air Force Laboratories.

c. Potential to aid the scientific community.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Submission of Proposals

The responsibility for carrying out DARPA's SBIR P ogram rests with the Technology Assessment and Long Range Planning Office. The DARPA Coordinator for SBIR is John K. Meson.

DARPA invites the small business community to send proposals directly to DARPA under the following address:

DARPA/TALRPO
Attention: John K. Meson
1400 Wilson Blvd.
Arlington, VA 22209-2308

The proposals will be processed in the Technology Assessment and Long Range Planning Office and distributed to appropriate technical offices for evaluation and action.

DARPA has identified 33 technical topics to which small businesses may respond. A brief description of each topic is included below. The topics originate from DARPA technical offices.

DARPA 87-1 Advanced Short Takeoff/Vertical Landing Aircraft (ASTOVL) Technology

Recent technological advances in high thrust to weight engines, composites aircraft structures, computer integration of flight/propulsion controls, and computation fluid dynamics have indicated that various concepts for ASTOVL aircraft may be feasible in the next decade. Several common technologies to all ASTOVL concepts need further investigation e.g., hot gas reingestion (computer modeling scaling laws, nozzle geometry); Fan Air Collection, valves, ducting (design code development, turning and mixing losses, low loss duct flow, etc); Thrust Augmentation by burning (low loss, compact burner technology) Jet Plume/Aircraft Structure Interaction (analytical prediction of jet plume trajectories, definition of thermal environment, Thermal/Acoustic fatigue testing of lightweight materials); Ground Erosion (code development on jet impungement and surface erosion mechanics, surface material treatments); Integration of Flight/Propulsion controls (determine impacts on system design, innovative architecture/redundancy).

DARPA 87-2 Low Observable Technology for Infrared Suppression on Aircraft

A technology base is required for advanced design that will allow the suppression of infrared signatures that contribute to aircraft detection or missile guidance against the aircraft. Techniques to cool propulsion system or airframe parts, coatings to reduce emissivity or to deflect aircraft radiance, or techniques to modify plume signatures as required.

DARPA 87-3 RPV Technology

Increased demands will be made on RPVs to achieve combination of higher altitude, longer endurance, greater payload capacity, higher velocity and increases in survivability. These drivers require extending the state of the art in the areas of structures, propulsion, control surfaces, reliability, weight reduction and the development of analytical and experimental techniques to evaluate potential improvements configured for a hostile natural environment. Methods need to be developed for the design and evaluation of low Reynolds number airfoils to achieve high performance small RPV.s To reduce drag induced by turbulent boundary layers, techniques are needed to evaluate concepts that suppress the turbulent mixing process in the boundary layer such as riblets, large eddy breakup device, etc. To achieve high maneuverability, control surfaces must be developed to achieve maximum lift increments in a minimum time without inducing stall. Stall reduction techniques will be a necessary compliment to any implementation. The understanding of turbulence induced loads needs to be extended through a combination of a vehicle aeroelastic model with an atmospheric model that develops the turbulent. Longer endurance leads to the need for improved reliability particularly in electronic components and for an increased on-board positional accuracy determination. A requirement exists to develop an inertial reference unit (IRU) whose design achieves high reliability through some combination of component improvement, redundancy, and fault tolerance and management.

DARPA 87-4 Interactive Radar Cross Section Calculations

Currently, few if any efforts have been directed towards the development of interactive three dimensional (3D) Radar Cross Section (RCS) calculations. Implementation of interactive color graphic algorithms on a personal computer would enable the user to model the 3D cross section he desired to evaluate. The personal computer can then output the data to a larger mainframe for RCS evaluation, and return the data to the personal computer Cathode Ray Tube (CRT) for evaluation or change. The use of color graphics will allow the user to represent materials with differing electromagnetic properties. It is desired that more dramatic and user-friendly graphics be provided so that a user can simulate a time domain pulse strike, penetrate, and propagate around a scatterer. Evaluation of a creeping wave around a damper-coated cylinder would be of particular interest. The interactive computation and display of bistatic RCS presented in a frequency domain plot or a 3D polar plot with radius corresponding to frequency versus azimuth would be of significant value to an RCS analyst. The ability to compute and display a bistatic scattering matrix for oblique incidence and the use of conformal coordinate system to model cross sections of interest would be of significant value to the RCS analysts.

DARPA 87-5 National Aero-Space Plane Technology Innovations

The National Aero-Space Plane (NASP) program incorporate major technological advances in: high temperature, high strength, oxidation, resistant, reusable materials; cryogenic fluid management; advanced turbulence and boundary layer transition modeling; ramjet/scramjet propulsion; active leading edge, nose and structural cooling and advanced high temperature instrumentation. This

research task will address any of the areas with innovative new design ideas suitable for eventual incorporation in a flight research vehicle. A first phase program of design, analysis and proof of concept experimentation should be described with sufficient concept descriptions to enable comparison with other approaches. The second phase would involve large scale test and analysis.

DARPA 87-6 Advanced Wind Tunnel Measurement Techniques

The area of aerodynamic wind tunnel has not experienced new and novel measurement techniques for years. Forces are measured through conventional measurements systems, air pressures are measured with either rakes or numerous slot/sensor holes in the vehicle, and temperature needs to be measured by sensors placed on or near the vehicle of interest. It is the thrust of this study to identify new and novel non-intrusive measurement wind tunnels. The primary area of interest is in the subsonic to transonic region. Approaches that allow the dynamic measurement of the various parameters identified will be considered.

DARPA 87-7 Advanced Radar Cross Section Measurement Analysis

Current measurement techniques for Radar Cross Section (RCS) provide a large amount of data about the target that isn't being used. Traditional techniques of looking at amplitude as a function of position can give the analyst the relative data but does nothing to identify the sources of the reflections. Various imaging approaches to help identify these "Hot Spots" have been implemented with varying degree of success. We are interested in new approaches and algorithms that can be used to assist the analyst in data assessment. Concepts that use Artificial Intelligence or Rule Base Expert Systems are one of the areas that would be strongly considered. New concepts that can extract RCS information in more timely manners without adding significantly more RF equipment would be considered. It is not anticipated that a radar range is needed to investigate/develop the approaches. Data will be made available by the Agency.

DARPA 87-8 Remote Detection of Nuclear Material

New ways are sought for monitoring the presence of nuclear weapons on the battlefield from a distance of at least several hundred meters. Traditional detection measurement schemes use "in situ" scintillation and ionization devices to detect primary, energetic products of radioactive decay of various nuclear materials. Direct detection using this kind of nuclear instrumentation has generally been unsatisfactory in the past due in part to the attenuating effects of the atmosphere at significant range.

Innovative methods are sought for detection using laser or microwave radiation as a means of remotely probing direct or induced radioactivity. Proposals must be based on the exploitation of sound basic physical concepts. Successful schemes must lead to devices which are portable and rugged and ideally be capable of differentiating among various elements and isotopes within an ambient background.

DARPA 87-9 Compact Accelerator Concepts

The size and weight of the current state of the art in the production and acceleration of very high current, relativistic electron beams is several orders of magnitude beyond what could be reasonably employed in a commercial or tactical military environment. New techniques for handling such beams, such as ion-focused guiding and branched-magnetic switching, have been recently developed within the Department of Defense and are believed to offer great potential application to this problem.

Innovative ideas are sought which would lead to the eventual development of electron beam accelerators capable of delivering high quality beams of between 10-100 kiloamperes accelerated at gradients of greater than 20 Mega-electron Volts (MeV) per meter to a total of several hundred MeV energy. Total weights less than several hundred tons are desired. Pulses are required at rates of 10-40 kHz in burst of 10-20 pulses each of which is 100 nanoseconds in length. Efficient injection, transport, and extraction are other crucial requirement. The offerer should demonstrate his/her innovative concept through analysis, design, and a limited demonstration.

DARPA 87-10 In-Processing Sensor Concepts for Intelligent Processing of Materials

DoD has increasingly stringent materials requirements in order to achieve many of its future systems concepts. These advanced materials will need to be processed, utilizing revolutionary concepts for process control which involved direct, in-situ, real time monitoring of the evolution of intrinsic features of the materials such as microstructure, phase change, defect formation, etc. DARPA has interest in research aimed at such sensors for processes including in bulk crystal growth of especially gallium arsenide and for critical steps in the production of advanced carbon-carbon composites. Proposals should address the rationale concerning which aspects of the process are key to successful, reproductible manufacture of such materials and how the specific sensor research proposed addresses the need.

DARPA 87-11 Electro-Optic Techniques for Very Large Scale Integrated Interconnect (VLSI)

A major limitation to achieving significant speed increases in VLSI lies in the metallic interconnects. They are costly, not only from the charge transport standpoint, but also from capacitive loading effects. The Department of Defense, in pursuit of the fifth generation super computer, will be investigating alternatives to the VLSI metallic interconnects, especially the use of optical techniques to transport the information, either inter- or intrachip. Interests include such areas as source and detector integration onto a VLSI chip, the optical control of integrated electronic devices, optical switching elements, reconfigurable optical channels, and all-optical genalized cross-bar switching networks.

Guided channels may be considered for intrachip interconnects, but the advantages of unguided optical channels should play a major role in solving interchip and interprocessor communications. Once the electronic signals have

been converted to optical signals, optical imaging and holography may be used to guide the optical beam to its destination which would likely be a photo-detector to another chip. One may go so far as to envision reprogrammable interconnects employing the optical phenomena of four-wave mixing. The bottom line in realizing opto-electronic interconnects is a need for research into nonlinear optics because it is the nonlinear aspect of optics that lies at the root of many of the desired operations - from integrated light sources, through optical switched and reconfigurable channels, to four-wave mixing. Consideration will be given to proposed studies into nonlinear optical materials, new device concepts, optical/electronic integration schemes, and interconnect architectures.

DARPA 87-12 Application of Adaptive Neural Networks

New approaches and concepts are sought to develop and apply novel computational methods associated with physiological models. Such methods might utilize models of human neurons and networks of neurons to deal with complex problems such as learning and planning. These networks of neuron models are often found to be adaptive to their environments, and respond to external changes by altering their input gains according to some functional relationship.

The goal is to apply these new techniques to problems associated with tactical air warfare avionics, such as trajectory determination, pattern recognitions, and adaptive threat response. Adaptation of computational approaches to utilize new ideas and hardware and software developments in parallel computing architectures is anticipated.

DARPA 87-13 Cement Paste Matrix Composite Materials

The DoD has interest in inorganic materials which can be processed under ambient conditions to form structural components possessing mechanical properties far superior to the currently available commercial concretes. In general, hydrated compounds of calcia, alumina and silica such as found in ordinary portland cement are known to react with water at room temperature to form the cement paste found in concrete. Research envisioned in this area will examine the relationship between the phases present in the microstructure and mechanical properties, i.e., strength, stiffness, toughness and durability. Portland cement chemistry may be used as a baseline for these studies but investigations of other cement paste systems are also encouraged. Particular emphasis should be given to determining principles by which this class of materials can be toughened and made much more durable than is possible using current technological practice. It is also of interest to examine the potential of tailored composite microstructures on which such cement pastes are used as the matrix material. The interaction of the cement paste matrix materials with carefully controlled dispersed phases of various chemical compositions and morphologies will undoubtedly produce composites with a broad range of mechanical properties. The goal of this research is to reveal the potential of this new class of materials with a low-cost, easily processed alternative.

DARPA 87-14 Instrumentation for Semiconductor Material And Device Characterization

Electrical characterization of devices often proves to be the most sensitive measurement for indicating problems in starting materials of processing techniques. Instrumentation is needed that can relate the electrical determination to elemental impurities and/or stoichiometric variations. The instrumentation programs proposed in this area should focus on either Gallium-Arsenide, Mercury Cadmium Telluride or electro-optic materials, and should clearly establish the methodology for relating the electrical or optical properties to the physical measurements. Emphasis is on new techniques which will provide new monolayer resolution in at least one physical dimension, or submicron resolution in two dimensions.

DARPA 87-15 Characterization of Millimeter-wave Devices

Solid state device technology is achieving structures that hold promise for achieving useable power gain in the Mm-wave region. Techniques for direct measurement of gain as well as for the complete parametric characterization of such devices are needed. Proposed techniques should be capable of at frequency measurement to at least 100 gigahertz.

DARPA 87-16 Analysis of Thermal and Shock Reduction of Composite Mechanical Properties

Directed energy weapons cause ablation and impulse loading when incident on a surface, which translates into thermal and shock effects interior to the material. Generally materials will be composites in conventional two-dimensional layups; flate plate geometry may be taken. Analysis is needed to describe the mechanical properties of the medium during and after irradiation by the directed energy beam, particularly when subjected to in-flight aerodynamic loads. Simplified techniques and results are especially required, with appropriate accuracy, to serve for sensitivity analysis of materials parameters and for trial compositions in combined (thermal/shock) hardened structures development.

DARPA 87-17 Speech Understanding Using High Level Knowledge

Speech recognition research is reaching the point of accuracy and performance where speech recognition and higher level natural language can be effectively combined. Proposals are requested for the development of techniques to allow for the processing of common speech dialogue that is both imprecise and errorful from a strict grammatical sense. Of interest are effective ways to utilize the power of high level language processing methods to aid in speech recognition. This is to include the processing of prosodic information such as stress or inflection to enable machines to interpret and understand the meaning of spoken input.

DARPA 87-18 Combining Database and Artificial Intelligence

Knowledge-based Systems have been successfully utilized in the rapid prototype development of complex military systems. In many cases these prototype systems have emphasized the need for techniques to integrate knowledge-based processing with methods for managing larges amounts of data and knowledge. Proposals are requested for the development of methods for both loose and tight integrations of these technologies. Included is the incorporation of more powerful techniques within data management modules to allow reasoning about special classes of data. Included also are techniques for efficiently storing large amounts of knowledge in various levels of abstraction to be used in a shared user environment to support advanced reasoning processes.

DARPA 87-19 Auditory Modeling for Speech Recognition

Advances in speech recognition have indicated the potential effectiveness of auditory models for front-end speech recognition analysis. Proposals are requested for developing and demonstrating techniques that model the human hearing process and extract features from a speech signal which can effectively be used by higher level processing agents for speech recognition and understanding.

DARPA 87-20 Secure Remote Electronic Switch

A capability is sought to provide a front-line unit commander with the ability to alter the status of multiple munitions using a coded signal transmission device. An example of the use of this device would be to turn a mine field on or off. The system should be highly reliable, jam resistant, low cost, and should provide acknowledgement of the status change. In addition, it should be extremely difficult to break the code, even after listening to the previous transmission or after capture of the receiving and/or transmitting unit.

DARPA 87-21 Photon Echo Memories and Computers

The quantum mechanical interaction of laser light with electronic states in certain cryogenically cooled crystals can lead to the phenomenon of the photon echo, in which re-emission of the photon occurs after a known delay time. Theory indicates that the delay can be long (compatible with Random Access Memory refresh modes in conventional computers). Computation indicates storage capacity of 10^{15} bits per cubic centimeter and access times in the sub-picosecond range. This task calls for laboratory experiments to demonstrate read write memories of 16 bits or higher in three years. Applications include high density storage for real-time processing in high performance imaging systems; and high speed computing for target classification and identification. Work should include demonstration of feasible access concepts and refresh modes.

DARPA 87-22 Magnetic Imaging Seeker

Most military targets of interest contain large amounts of magnetic materials. Conventional seeker technology for negating tanks, artillery and other similar weapons relies on exploitation of optical, millimeter wave and infrared

signatures for detection of target in clutter. These seekers concepts require sophisticated electro-optical imaging concepts that degrade in high clutter and certain combinations of target and weather conditions. This Research Task will investigate the feasibility of magnetic imaging concepts as replacement or adjunct to conventional tactical seekers. The investigator will recognize and isolate tactical targets in clutter at various ranges out to a few kilometers. These arrays should be capable of eventual packaging in small auxiliary sensors, strapdown operation, accuracy, influence of the earth's magnetic field and the effects of simple countermeasures. If necessary the investigator will recommend development of miniature magnetometers with properties compatible with the requirements derived during the initial study phase. The second phase of the program will proceed either to the development of a test array or to testing of development magnetometers. Proposals must contain analysis indicating preliminary feasibility assessment.

DARPA 87-23 High Power Density Components for Electromagnetic Launchers

Electromagnetic launchers are being considered for a variety of missions including anti-aircraft, armor and ballistic missile defense. Innovative concepts are needed in a variety of technologies relating to the repetitive operation of such devices as practical weapon systems. Acceleration concepts that mitigate or eliminate high current opening switches are needed. High power density electrical power supplies and pulse forming networks are desired to minimize the total system weight. Techniques for reducing and rejecting the waste heat generated in switches, rails, inductors and other components are desired for both ground and space based systems. Innovative launcher concepts for applying electrical energy to achieving high projectile velocities with high efficiency are particularly sought.

DARPA 87-24 Special Materials for High Current Switches

Electrical pulsed power devices are being developed for a variety of weapons applications. Power conditioning circuits for these very high power devices require non-linear circuit elements which exhibit large changes in electrical conductivity.

Solid materials which have reversible phase changes with associated conductivity changes of three or more orders of magnitude would have many applications. Such materials would desirably be capable of dealing with current densities as high as 1000 amperes/sq. cm. in their conductive state.

There are available a very limited number of materials which undergo reversible phase changes near ambient temperatures and which have the desired electrical properties. Experimental efforts which would identify and characterize new materials would be of interest to DARPA.

DARPA 87-25 Standoff Detector for Mines and Explosive Devices

A capability is desired to enable dismounted troops, armored vehicles, and/or aircraft to detect the presence of explosive filled ordnance, especially mines, at ranges of military interest. As an estimate, these ranges extend from 10 to 100 meters for dismounted troops, 50 to 500 meters for armored vehicle, and 250 to 2,500 meters for aircraft. In all cases, maximum range is

desired. Characteristics of mines include the following. The mines may be on the surface or buried up to one foot underground. They may have metal or plastic cases. They will generally contain high explosives. They will vary from approximately 1 to 10 kilograms. They may have pressure, anti-disturbance, magnetic, seismic, or combination fuzes.

Concepts which address only a portion of the desired capability will be considered if their military value can be shown.

DARPA 87-26 Instrumentation to Measure the Characteristics of Currents At and Near the Ocean's Surface

We require the development of instrumentation to measure precisely currents and current gradients at and near the surface of the ocean. Ideally, the instrumentation should be capable of measuring from the surface to one meter depth, in increments of one millimeter, and in all three dimensions. One centimeter increments is an acceptable minimum capability. Ideally, the instrumentation should have a velocity resolution of one millimeter per second accurately measure velocity gradients down to at least one meter depth, and measure strain rates of 10^{-6} per second.

It is preferred that the system be non-contact, reasonably portable, and easily set up by trained personnel.

Concepts which approach or meet only certain of the above requirements will be considered if their value can be shown.

DARPA 87-27 Synthetic Aperture Radar Image Processing Studies

Proposals are sought dealing with the processing of Synthetic Aperture Radar (SAR) images. New ideas and concepts are desired for speeding up the processing time required to form a SAR image. Such processing essentially involves performing a two-dimensional convolution on coherent radar data consisting of the target range and target doppler. Specific ideas are sought in any or all of the following areas.

a) use of phase information derived from coherent radar return signal
b) application of parallel processor architectures for SAR image formation
c) ability to process data in polar coordinates
d) use of frequency diversity techniques for SAR image formation

The contractor must have computer facilities for doing such processing as described above and should be able to process the radar ocean monitoring satellite (SEASAT) data as a minimum.

DARPA 87-28 Synthetic Aperture Radar Image Enhancement Studies

Proposals are sought for image enhancement techniques and algorithms for Synthetic Aperture Radar (SAR) images. The contractor should be able to work with standard image pixel format data tapes and must demonstrate a capability in image analysis and manipulation. Existing image processing equipment is essential for any potential offeror. Algorithms and pattern recognition schemes are sought for the detection of weak surface signals in ocean clutter.

Techniques should examine random position orientation of the signal and should investigate the impact of non-Rayleigh background statistics. The offeror should be able to work with images derived from the radar ocean monitoring satellite (SEASAT) experiments. The ability to generate simulated images for the expected range of signals and clutter conditions would be a valuable asset.

DARPA 87-29 Military Application of Artificial Oxygen-Converting "Gill"

An unclassified technology being developed for DARPA by the Aquanautics Corporation in San Francisco promises a future capability to remove efficiently dissolved oxygen from seawater. System concepts which may be enabled by the technologies need to be enumerated and evaluated. Some applications that might be considered include underwater power and propulsion, swimmer delivery vehicles, medical oxygen, life support oxygen for submarines, and remote site industrial oxygen generation.

The work requested should include an enumeration of concepts, a feasibility study of the more promising ones, and a development plan for recommended applications.

DARPA 87-30 Video Arcade Level Training Devices

New ideas are sought for the use of video arcade level technology in low cost training devices for military combat skills. Areas of interest include but are not limited to new graphics concepts, computer generated realistic opponents, and networked devices. The target costs for production versions of such devices is $10,000 and below.

DARPA 87-31 Simulators for Individual Infantry Soldiers

Ideas are sought for creating simulation environments for individual infantry soldiers performing combat skills as members of small teams. Current simulator technology is well-suited for combat vehicles (e.g., flight simulators for fighter aircraft), but simulators for an individual moving on the ground, assuming combat positions, and engaging opponents, has proven technically difficult. Ideas on how to create such simulations leading to prototype construction, are sought.

DARPA 87-32 Special Effects for Simulators

Simulators involve the use of illusory technology to create realistic environments for the operators, e.g. sights and sounds of the battlefield. Ideas are sought on ways to employ new techniques in special effects technology to increase the realism of simulators. Promising applications will likely be tested in prototype simulators for evaluation.

DARPA 87-33 Digital Data Base Construction for Computer Image Generation

Advances in networked microprocessor work stations allow new methods for digitizing cartographic, topological, pictorial, and feature data for use in digital data bases feeding computer image generation graphics computers. New

ideas are sought for the application of this type of technology to data base construction, particularly techniques which will allow the rapid construction of high detail data bases. Ideas can be theoretical as well as application and machine specific.

SUBMITTING PROPOSALS ON DEFENSE NUCLEAR AGENCY TOPICS

The Defense Nuclear Agency is seeking Small Business firms with a strong research and development capability and experience in nuclear weapons effects and nuclear weapons phenomenology areas. Proposals should be submitted to:

Headquarters
Defense Nuclear Agency
Attn: AM/SBIR
Washington, D.C. 20305-1000

Handcarried proposals should be submitted to:

Headquarters
Defense Nuclear Agency
Attn: AM/SBIR
6801 Telegraph Road
Alexandria, VA 22310

Questions concerning the research topics should be submitted to :

Ms. Betty Fox
(202) 325-1078

The research categories proposed for study under this program are:

1. Nuclear Weapons Effects.
2. Nuclear Effects Simulation.
3. Instrumentation.
4. Directed Energy Effects.
5. Nuclear Hardening and Survivability.
6. Security of Nuclear Weapons.
7. Operational Planning and Force Structure.
8. Theater Nuclear Forces (TNF) Survivability.

These topics are further explained below. Additional information beyond that provided herein may be obtained by request from the address given above.

DNA 87-1. TITLE: Nuclear Weapons Effects

DESCRIPTION: Exploratory Development: Nuclear weapons effects include air blast, thermal, ground shock, water shock, cratering, personnel, and dynamic loading. Of particular interest is the response of materials, structures, and systems to these nuclear weapons effects. Materials of interest include metals, ceramics and composites. Any new material capable of being used as a structural member is of particular concern for aircraft, missiles, ships (both surface and subsurface) and military vehicles. The response of underground structures, such as missile silos, command and control facilities and communications facilities are especially important. Also of interest are transient and permanent radiation effects on new types of electronics and sensors. Concepts and techniques which will improve the survivability (decrease the response) of systems to these nuclear weapons effects are required.

DNA 87-2. TITLE: Nuclear Effects Simulation

DESCRIPTION: Exploratory Development: International treaties preclude the testing of nuclear weapons in the atmosphere and hence we are unable to test military sytems in an actual nuclear environment. To compensate for this, other test techniques are used to simulate the effects of the nuclear detonation. Nuclear weapons effects simulation includes: high explosive testing to simulate the mechanical effects, EMP simulation, thermal radiation simulation,, and nuclear radiation simulation. Simulation techniques should be as realistic as possible, relatively inexpensive to perform and comparable to the threat environment. Improvements to nuclear simulations are required to address their possible use in a training and/or operational sense for combat troops. An extensive program currently exists for all areas of simulation and one should become familiar with those to see how they can be improved and/or combined in order to make the total process more realistic and more representative of the actual nuclear weapons effect being studied. Both destructive and non-destructive test methods are desired.

DNA 87-3. TITLE: Instrumentation

DESCRIPTION: Exploratory Development: Instrumentation is used for measuring nuclear weapons effects and phenomenology parameters and the response of test items exposed to these weapons effects. The instrumentation should be capable of operating under very harsh conditions, such as might be encountered in an underground nuclear test, a high explosive test, or test involving high levels of x-ray, gamma, or neutron radiation. The instrumentation should, for the most part, be survivable and include recording, data transmission and data analysis capabilities. Concepts are required for new instrumentation utilizing state of the art technology which will result in improved data collection with better accuracy at lower cost.

DNA 87-4. TITLE: Directed Energy Effects

DESCRIPTION: Research: The effects of directed energy (e.g., lasers) sources on materials, structures and systems are of interest. Of particular interest is the establishment of the correlation between nuclear weapons effects and directed energy effects, the identification of materials which are capable of withstanding both nuclear weapons

effects and directed energy effects, and mechanisms by which the directed energy effects actually interact with target materials/structures.

DNA 87-5. TITLE: Nuclear Hardening and Survivability
DESCRIPTION: Engineering Development: Techniques for nuclear hardening and survivability of systems/structures against nuclear weapons effects and, where compatible, directed energy effects are required. These techniques should protect the structure or system against the combined effects of blast, thermal and nuclear radiation in the cases of structures or materials, and should also provide protection against electromagnetic and radiation effects wherever any electronic capabilities are involved. In particular, the ability to harden communications facilities and surveillance sensors against electromagnetic pulses is required.

DNA 87-6. TITLE: Security of Nuclear Weapons
DESCRIPTION: Exploratory Development: Measures to improve the security of nuclear weapons against all possible threats are required. This includes the design of security features both for the actual weapons and for the facilities in which weapons are either stored or transported. These security measures should protect against all known or predicted threats and should be done in such a way as to avoid making the protected item visible as a target.

DNA 87-7. TITLE: Operational Planning and Force Structure
DESCRIPTION: Research: The nuclear employment planning capabilities of operational commanders in tactical, strategic and integrated warfare environments should be improved. Improvements desired include development of automated planning systems, techniques to determine target damage objective and criteria, post strike target damage assessment capabilities, and automated nuclear weapon employment codes. Also included are those force structure issues pertaining to the effectiveness, security, and survivability of nuclear forces.

DNA 87-8 TITLE: Theater Nuclear Forces (TNF) Survivability
DESCRIPTION: Exploratory Development: The prelaunch survivability (PLS) of the TNF is of vital concern. New and innovative concepts to improve PLS are needed to retain a viable nuclear strike capability and to enhance deterrence. The threats to the TNF include enemy forces conducting unconventional, conventional, chemical and nuclear warfare during periods of peacetime, transition to war, and war. Long range program thrusts include peacetime and field storage, deceptive/OPSEC practices, theater nuclear force movements, and operational survivability of theater nuclear systems (aircraft, missiles, and cannon systems). Survivability concepts are wanted for the period of the 1990's and beyond. Concepts should employ innovative ideas and make use of new and emerging technologies.

STRATEGIC DEFENSE INITIATIVE ORGANIZATION (SDIO)
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
Submitting Proposals

Phase I proposals (5 copies) should be prepared for routine US Mail and addressed to:

Strategic Defense Initiative Organization
Attention: IST/SBIR
The Pentagon
Washington, DC 20301-7100

Since no provisions will be made to receive hand carried proposals, bidders should allow ample time for routine delivery of proposals by the US Post Office. The above address can not be used for commercial delivery services or hand carry.

The SDIO SBIR Program supports science and engineering at the cutting edge of technologies that, if successful, will have a significant impact on the mission of SDI. Topic areas of special interest to SDI are described in the following paragraphs. The efforts supported will be innovations ultimately leading to a product or process that potentially can be used in strategic defense.

Many of the concepts being addressed by SDI involve major ground or space based systems which tax the capability of even the largest corporations. Although the total systems may be beyond the capability of a high-technology small business, many of the subsystems, components, processes, etc. fall within the scope of this solicitation. Accordingly, the prospective bidders can interpret the SDI topics in terms of how they can contribute to the solution of the broader problems and challenges described in this solicitation. In many cases, the thrust of a topic includes establishing feasibility of concepts, enabling major advancements in capability, etc., rather than production. For example, the deliverable from a successful Phase II effort could be a prototype which becomes an element in a demonstration program; the follow-on Phase III could be further research to perfect the approach following testing or evaluation.

Phase I proposals must be confined to strategic defense innovative technologies, advanced concepts, or novel approaches, that in Phase II either may be carried out to laboratory prototype, or can lead to the next generation of products or processes. Phase II awards may not necessarily complete the total research and development that may be required to satisfy strategic defense needs; completion of the research and development of products or processes for use by SDI may occur during Phase III. Ultimately, Phase III must address the development of products or processes for use by SDI. Ideally, the research should make a significant contribution to the solution of an important SDI problem through a product or a process and provide the small business firm with the basis for a new product, process, or service.

Some activities will not be funded in Phases I or II: technical assistance, compilations of works of others, technology status surveys, technology assessments, development of technically proven ideas, product development, demonstration projects, or pilot plants. Research and development on incremental or scaled-up versions of existing technologies may be permitted if the additional R&D is necessary to meet significantly different conditions as stated in the topic descriptions.

FY1987 SBIR Topics
Strategic Defense Initiative Organization

SDIO 87-1. Title: Directed Energy Concepts

DESCRIPTION: Innovative research in the generation and propagation of directed energy plays an important role in the determination of effective ballistic missile defense systems. Systems being considered include (but are not limited to) chemical lasers, excimer lasers, nuclear and non-nuclear driven x-ray lasers, gamma-ray lasers, free electron lasers, neutral and charged particle beams, and plasmoids. Hybrid approaches are also of interest. Interests in the concepts include the full range of embodiments, i.e., light weight spaced-based, ground-based, and pop-up systems. Included in the directed energy problems are such diverse topics as weapon pointing, beam control, acquisition, tracking and pointing, mirror technology, beam propagation through natural and disturbed environments, and countermeasures. Approaches are needed that either extend or improve the present concepts. Approaches that facilitate or support the evaluation of concepts are also appropriate.

SDIO 87-2. Title: Kinetic Energy Weapons

DESCRIPTION: Along similar lines to the topic SDIO 87-1, kinetic systems are candidates for ballistic missile defense. Systems being considered include (but are not limited to) electromagnetic rail guns, plasma guns, and other hypervelocity projectile concepts as well as chemically-propelled interceptors. Included in the kinetic energy weapons area are smart projectiles development, homing devices, launcher designs, engagement tactics, hypervelocity aerocontrol/thermal protection, and countermeasures. Approaches are needed that either extend or improve the present concepts. Approaches that facilitate or support the evaluation of concepts are also appropriate.

SDIO 87-3. Title: Sensors for Surveillance, Acquisition, and Discrimination

DESCRIPTION: Sensors and their associated systems will function as the "eyes and ears" of a space-based ballistic missile defense system, providing early warning of attack, target identification, target tracking, and kill determination. New and innovative approaches to these requirements using unconventional techniques are encouraged across a broad band of the electromagnetic spectrum, from radar to gamma-rays. Passive, active, and interactive techniques for discriminating targets from decoys and other penetration aids are solicited. In addition to novel sensing concepts, sensor-related device technology is also needed, with the intended goal of producing either a specific product or process. Examples of some of the specific areas to be addressed are: cryogenic coolers (open and closed systems), algorithms, low power optical beam steering, synthetic aperture lidar and radar, passive imaging (infrared to ultra-violet wave), interferometry, beam coherence and positioning, low-signal gamma-ray detection, neutron detection, and frequency-scanning laser techniques for active discrimination. Approaches are needed that can extend and improve the efficiency of present concepts.

SDIO 87-4. Title: Nuclear Space Power Concepts

DESCRIPTION: Weapons, sensing, and communications systems under consideration for strategic defense have diversified power requirements. Methods and processes are being considered for a wide spectrum of power and power conditioning situations. Nuclear power concepts and the associated components are of interest for both manned and unmanned spacecraft. The power duty cycles to be considered include: hundreds of MW power for pulse applications, sustained hundreds of KW to MW power for electric propulsion, continuous tens to hundreds of KW power for house keeping, tracking, etc. This category includes auxiliary components and sub-systems vital to the operation of the power system. The energy conversion approaches include: thermoelectric, thermionic, and Brayton cycle. New approaches leading to controlled wide excursions of power and burst mode power are sought. Innovative high power thermal radiator concepts are needed for all types of power cycles. Also, concepts and systems that enhance safety, maintainability, and reliability of space nuclear power systems are sought.

SDIO 87-5. Title: Non-nuclear Space Power and Power Conditioning

DESCRIPTION: Along the lines of topic SDIO 87-4, non-nuclear approaches are sought. Applications in space demand high energy densities. The power duty cycles to be considered include: hundreds of MW power for burst applications, sustained hundreds of KW to MW power for electric propulsion, continuous tens to hundreds of KW to MW power for house keeping, tracking, etc. Specific topics include novel battery concepts, chemically driven systems for burst power, advanced solar collectors and converters, inductive and capacitive stores, space-based MHD generators, heat dissipation systems, signature control, and plasma switches. Also, concepts and systems that enhance maintainability and reliability of space power systems (e.g. insulation and cable) are sought.

SDIO 87-6. Title: Propulsion and Logistics

DESCRIPTION: Strategic defense places unprecedented demands on all types of space transportation and propulsion systems; launch to low earth orbit, orbit transfer, orbit maneuvering, and station keeping. In particular, advancements are needed to achieve major reductions in the costs of placing and maintaining payloads in the desired orbit. Traditionally, the cost of space transportation and the operations of the spacecraft have been major factors in determining the life cycle costs of space-based assets. This burden on the deployment of strategic defense systems has been identified a major cost driver. Approaches leading to techniques, methods, processes, and products in support of these propulsion and logistics objectives are sought.

Propulsion approaches include liquid, solid, transatmospheric air-breathing, and electric. Advancements are needed in propulsion-related areas, e.g., extending storage time of cryogenic fluids, reduction of contamination from effluents, and sensors and controls for autonomous operation. In space transportation and support primary emphasis is on reducing the cost of space operations. Areas of interest include the entire spectrum of space transportation and support: efficient launch systems, assembly, and control systems; expendable and

recoverable components; improved structures and materials; increased propulsion efficiency; and significant reduction in the manpower intensive tasks of production, assembly, checkout, operations, and control.

SDIO 87-7. Thermal Management

DESCRIPTION: The high power levels for space stations will need effective heat dissipation. Topics 87-4 and 87-5 state the power levels. Innovations are sought in thermal radiators and associated devices for all types of space-based power cycles, nuclear and non-nuclear.

SDIO 87-8. Title: System Survivability

DESCRIPTION: The survivability of various components of a space-based missile defense system will be a key issue in the effectiveness of such a system. Products, processes, and techniques for active and passive hardening against directed and kinetic energy devices are sought. Components to be made survivable include sensors, battle management systems, power systems, and directed/kinetic energy weapon configurations. Survivable sub-components include large and small optics, electronics, structures for support and fuel containment, and specific materials critical for shielding, maneuvering, propulsion, and targeting. In addition to shielding, other well designed and innovative countermeasures are encouraged. Specific examples of areas to be addressed include thermo-mechanical shock hardening, heat dissipation techniques, protective coatings, baffling techniques, materials conditioning, orientation or deployment strategies, and insulation methods. Of particular interest is hardening and survivability against x-ray lasers and bright short wavelength ground-based lasers.

SDIO 87-9. Title: Target Lethality

DESCRIPTION: A major factor in determining the effectiveness of a ballistic missile defense is the lethality of the directed and kinetic energy devices against responsively hardened targets. The key questions that need to be addressed under this topic deal with the quantitative assessment of target lethality. Hence, techniques are needed to acquire, access, and query an extensive data base on the damage to basic materials, electronics, and optics due to various mechanisms. Techniques are needed to quantify laser radiation damage due to ionization, thermal deposition, and impulse shock as a function of wavelength, intensity, and pulse characteristics. This is required in order to direct future research in novel directed energy concepts. Similar techniques are needed to investigate and quantify damage mechanisms due to particle beam interaction with targets. In the area of kinetic energy, the effects of hypervelocity projectile impact on structural and hardened materials are of extreme interest. Finally, innovative ideas or concepts for measurement of radiation or particle penetration, structural damage due to thermo-mechanical stress, opacities of plasma blow-off, and equation-of-state data are relevant.

SDIO 87-10. Title: Computer Architecture and Very High-Level Language Design for Battle Management

DESCRIPTION: Strategic defense systems for battle management demands order-of-magnitude advances. The system must acquire and track thousands of objects with hundreds of networked sensors and data processors, direct weaponry to intercept targets, and determine the degree of kill. Three areas of interest are:

- New computer architectures which are lightweight, compact, fault-tolerant, and hardened to radiation, but allow for the extremely rapid processing of data that will be required. This issue can be addressed via either new designs for computer components (e.g., optical signal processors) or innovative architectures using existing technology.

- Very high-level language (VHLL) design for both the development and testing of extremely large software systems.

- Novel numerical algorithms for enhancing the speed of data processing for sensing, discrimination and systems control. These may be specifically tailored to a particular architecture, since the computer will likely be a single-purpose design suited to the strategic defense data processing task.

Supporting concepts are also sought. Examples of these include secure laser satellite networking of battle managers and sensors, and deployment strategies of components in a battle environment.

SDIO 87-11 Title: Optical Computing and Optical Signal Processing

DESCRIPTION: Dense computing capability is sought in all architectural variations, from all optic to hybrid computers. Specific examples of areas to be addressed include, but are not limited to, high speed multiplexing, monolithic optoelectronic transmitters, holographic methods, reconfigurable interconnects, optoelectronic circuits, and any other technology contributing to advances in intra-computer communications, optical logic gates, bistable memories, optical transistors, and power limiters.

SDIO 87-12. Title: Space Structures

DESCRIPTION: The strategic defense mission places great demands upon the design of space structures to be used for their fabrication. The requirements include structures for prime power systems, antennas, tracking and pointing systems, solar collectors, and pressure vessels. All of these present individual challenges in terms of stiffness, impact resistance, high temperature capability, deployment, etc. Most of the anticipated situations depend on major improvements in material properties, cost effectiveness, and prediction methodology. Space structures supporting weapons and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter. Techniques for both passive and active control of

the structural dynamic responses to environmental and operational excitations are needed. Methods are needed to predict the dynamic performance and stability characteristics of structures acting in concert with on-board distributed controllers for maneuvering, pointing, and vibration/noise suppression.

SDIO 87-13. Structural Materials

DESCRIPTION: Many of the anticipated structural advances sought in Topic 87-12 will depend on major improvements in material properties, cost effectiveness, and prediction methodology. Space structures supporting weapons and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter.

Techniques are needed to obtain greatly improved understanding of structure-property relationships for advance carbon/carbon, ceramic-matrix, and metal-matrix composite materials. Specific goals requiring advanced techniques and processes include imparting oxidation resistance and damage tolerance to carbon/carbon composites, enhancing the static and dynamic toughness of ceramic composites and creating fatigue-resistant metal composites with order of magnitude improvements in passive vibrational damping. Methods are needed to establish the thermodynamics and kinetics basis for minimizing fiber-matrix reactions in composites exposed to high operating temperatures. Methods are needed to address the basic mechanics of failure characteristics and fatigue behavior under complex mechanical and thermal loadings. Tribology innovative techniques and ideas are sought in areas such as solid and liquid lubricants, moving mechanical assemblies, lightweight alloys, and antiwear adhesives. Advances are sought in materials for optical systems, components, and radiation hardening. Proposals involving these as well as other space structure and material-related research and innovative technology topics are encouraged.

SDIO 87-14. Title: Electronic Materials

DESCRIPTION: The necessary advances in electronics for the many strategic defense applications will require advances in electronics materials. Primary emphasis lies in advancing the capability of integrated circuits, detectors, sensors, large scale integration, radiation hardness, and all electronic components.

Reference A

TO: SBIR Proposers

To prepare better informed proposals addressing any of the topics presented in this DoD SBIR Program solicitation, you may request bibliographies of technical reports produced by prior DoD-funded R&D projects related to appropriate topics; bibliographies will include references to other sources of related information. Additionally, you will receive, if available, information about related DoD-funded R&D projects in progress. You may also request a copy of any of the technical reports you select from the bibliographies.

DTIC authorization to provide this service expires January 9, 1987, the DoD SBIR Program Solicitation 87.1 closing date.

Please use the request form below; fold, staple, stamp, and mail it back to DTIC. Type or print legibly complete and accurate information. Be sure to indicate in the space provided that your firm qualifies as discussed in Section 2.0 of this solicitation document.

SMALL BUSINESS INNOVATION RESEARCH PROGRAM REQUEST FOR DTIC'S SERVICES

REQUESTER ______________________________ ______________________
NAME TITLE/POSITION

ORGANIZATION NAME ______________________________________

ADDRESS ____

______________________________________ Area Code / ____________
CITY STATE ZIP CODE TELEPHONE NUMBER

Please send technical report bibliographies and other information on the following DoD SBIR solicitation R&D topics:

DoD COMPONENT	TOPIC NO.		DoD COMPONENT	TOPIC NO.
______	______		______	______
______	______		______	______
______	______	PLEASE TYPE OR PRINT	______	______
______	______		______	______
______	______		______	______

Company Status: I confirm that the small business concern identified above meets the SBIR qualification criteria presented in Section 2.2 of the DoD SBIR Program Solicitation No. 87.1.

____
Signature of Requester

STAPLE HERE

PLACE
STAMP
HERE

RETURN ADDRESS

Defense Technical Information Center
ATTN: SBIR
Cameron Station
Alexandria, VA 22304

FOLD ON DOTTED LINE

Reference B

TO :
(Fill in firm's
name and mailing
address)

SUBJECT
(Fill in topic : SBIR Solicitation No. 87.1
No.) Topic No. ______________

This is to notify you that your proposal in response to the subject solicitation and topic number has been received by ________________
(Fill in name of

____
organization to which you will send your proposal.)

______________________________ __________
(Signature by receiving organization) (Date)

Reference C

Director of Small and Disadvantaged Business Utilization (SADBU) Specialists Assigned at Defense Contract Administration Services Regions (DCASRs) and Defense Contract Administration Services Management Areas (DCASMAs)

DCASR Boston
495 Summer St.
Boston, MA 02210-2184
Tel: 617/451-4317
ATTN: Edward Fitzgerald

DCASMA Boston
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Tel: 617/451-4109
ATTN: Tom Sexton

DCASMA Hartford
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ATTN: John Richards

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DCASMA San Antonio
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